TECHNICAL MANUAL

RESPIRATORY HUMIDIFIERS
MODELS:
MR730
MR720
MR700
MR480

Revision F

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Technical Manual for Respiratory Humidifier
MR730 Dual Servo
MR720 Dual Servo (anaesthesia)
MR700 Dual Servo
MR480 Single Servo

Fisher & Paykel Healthcare have a policy of continued product improvement and reserve the right to alter specifications without notice.

Revision F changes,

Section	Description of Change
6.0	Routine Performance test shortened (Dynamic test removed).
7.33	Software Compatability Updated
8.10	Spares list additions
9.0	Change history updated
Appendix B	Maintenance Schedule Changed for Temperature Probes
Appendix D	Cleaning Procedures Rewritten
Appendix E	Dynamic performance check made an optional extra

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1.0 MR700 SERIES GENERAL SPECIFICATIONS

This documentation defines the technical specifications of the MR730, MR720, MR700 and MR480 respiratory humidifiers, it also includes maintenance and repair procedures.

The MR730/720 models are Heated Wire humidifiers with the option of disabling the Heater Wire.

The MR720 has a lower alarm limit and an extended warmup mode for use in Anaesthesia.

The MR700 model is exclusively a Heated Wire humidifier.

The MR480 model is a non Heated Wire humidifier.

1.1 ELECTRICAL SPECIFICATIONS

1.1.1 MODELS MR730/720/700

Supply Voltage	230 ± 25 V
	127 ± 12 V
	115 V
	100 ± 10 V
Supply Frequency	50 or 60 Hz
Supply Current	1.0 A maximum at 230 V
	1.9 A maximum at 127 V
	2.0 A maximum at 115 V
	2.4 A maximum at 100 V
Heater Wire Capacity	60 W

1.1.2 MODEL MR480

Supply Voltage:	230 ± 25 V
	115 V
	100 ±10 V
Supply Frequency	50 or 60 Hz
Supply Current	0.7 A maximum at 230 V
	1.4 A maximum at 115 V
	1.6 A maximum at 100 V

1.1.3 COMMON ELECTRICAL SPECIFICATIONS (ALL MODELS)

Heaterplate Power	150 W
Heaterplate Overheat Protector	Operates at 118 ± 6 °C

1.2 STANDARDS AND APPROVALS

Classification under:	CSA-C22.2 No.125 , UL2601
	IEC601-1, AS3200.1, EN60601-1
	Class 1
	Type B
	Drip Proof
	Continuous Operation
	Not to be used in the presence of flammable anaesthetics.

1.3 TEMPERATURE CONTROL

PID (Proportional Integral Derivative) control of Heater Wire (in Heated Wire mode operation only) and heaterplate.

1.4 TEMPERATURE SENSING

Temperature measurement using standard characteristic thermistors (YSI 400 compatible) mounted in fast response temperature probes, located at the patient end of the delivery tube and at the humidifying chamber outlet.

1.5 TEMPERATURE DISPLAY

Three digit 14mm 7 segment LED (Light Emitting Diode) display.

Range 5.0 to 80.0 °C. Below 5.0 °C displays ‘Lo’. Above 80.0 °C displays ‘Hi’.

Accuracy 25.0 ± 0.3 °C to 45.0 ± 0.3 °C.

1.6 GLOSSARY OF ABBREVIATIONS

EOH	The End Of Hose temperature.
OFFSET	The temperature difference of the TOP from the SET.
SET	The temperature Set potentiometer. Sets the controlling temperature of the EOH.
TOP	The temperature at the Top of the humidification chamber.
RSD	Remote Shut Down.

2.0 OPERATING CONTROLS AND MODES

2.1 ADJUSTABLE CONTROLS

2.1.1 AIRWAY TEMPERATURE CONTROL

Selects the airway controlling temperature. The range of adjustment is from 31 to 40 °C over a linear scale marked in degrees on the front panel.

The temperature can be set with a resolution of 0.1 °C. The set temperature is flashed on the display when the control knob is rotated and continues to be flashed for five seconds after the last adjustment.

2.1.2 CHAMBER CONTROL (HEATER WIRE ON MODE ONLY)

The temperature of the gas leaving the chamber is regulated by the Chamber Control knob, it sets the difference between the chamber outlet temperature and the airway temperature delivered to the patient. The setting of the Chamber Control, when added to the setting of the Temperature Control, determines the chamber outlet set temperature. This Chamber Control has a linear range of adjustment from -5 to +2 °C marked in one degree steps and can be set with a resolution of 0.5 °C. The value is flashed on the Airway display as the control knob is rotated and continues to be flashed for five seconds after the last adjustment.

Every humidifier is also supplied with a fixed chamber control knob. This prevents inadvertent adjustment of the chamber control by preadjusting the existing knob to the desired setting and then replacing the normal knob with the fixed knob.

2.2 PUSH SWITCHES

2.2.1 MUTE BUTTON

A momentary push will disable an audible alarm for 3 minutes (except low temperature alarm in non heater wire mode which is 10 minutes).

A secondary function is that in conjunction with the Chamber Temp switch enables entry to the engineering menu (refer Appendix A2).

On every initial push of the mute button a momentary audio beep indicates function operation.

2.2.2 CHAMBER TEMP BUTTON

MR700 Series Humidifiers with Version 1.0 Software:

Operation of this switch causes the airway temperature display to momentarily blank then show the chamber outlet temperature. A green LED adjacent to the switch is enabled to indicate that this function is active. On release of this switch the display reverts immediately to show the airway temperature.

This button is used in conjunction with the mute to enter the engineering menu (refer Appendix A2).

MR700 Series Humidifiers with Version 2.0 and Version 3.0 Software:

Operation of this switch causes the airway temperature display to momentarily blank then show the chamber outlet temperature. A green LED adjacent to the switch is enabled to indicate that this function is active. On release of this switch the display continues to show the chamber outlet temperature for 2 seconds before blanking momentarily and reverting to show the airway temperature.

This button is used in conjunction with the mute to enter the engineering menu (refer Appendix A2).

2.2.3 STANDBY BUTTON (MR700/720/730 ONLY)

This button has to be depressed for one second to enter or exit the standby mode. When the adjacent amber LED starts to flash (100/minute) the button can then be released and the Humidifier remains in the standby mode.

To exit Standby mode press the Standby button for 1 second, the amber LED will then turn off. An audio beep accompanies a change in the Standby mode state.

2.2.4 HEATER WIRE SWITCH (MR720, MR730 ONLY)

This is a latching, push operated, switch which selects between the heater wire mode and non-heater wire mode. The adjacent green LED, if on, indicates that the humidifier is operating in the heater wire mode. Pressing this switch will cause an audible beep and the LED changes to indicate the new state. A heater wire alarm will commence if switching to the heater wire mode with heater wire disconnected or if switching to the non heater wire mode if a heater wire is connected.

2.3 POWER UP SEQUENCES

2.3.1 VERSION 1.0 SOFTWARE

After switch on the humidifier goes through the following sequence. Note that each displayed information is flashed for 2 seconds.

- Watchdog circuit test — If successful the 'SEE MANUAL' LED lights briefly.
- Display Test — All indicator LEDs are illuminated and '**8.8.8**.' is displayed on the Airway Temperature display
- Temperature Control Setting — eg '37.0' is displayed
- Chamber Control setting — If heater wire mode is selected then the chamber control setting is displayed eg '-1.0'. Not applicable for MR480
- Software Version Number — '1.0'
- Maximum Heaterplate setting — eg '110'
- Audio Beep

2.3.2 VERSION 2.0 AND VERSION 3.0 SOFTWARE

After switch on the humidifier goes through the following sequence. Note that each information is displayed for 2 seconds, then the display is momentarily blanked.

- Watchdog circuit test — If successful the 'SEE MANUAL' LED lights briefly.
- Display Test — All indicator LEDs are illuminated and '**8.8.8**.' is displayed on the Airway Temperature display
- Model Number — eg '730'
- Software Version Number — eg '2.0'
- Temperature Control Setting — eg '37.0' is displayed
- Chamber Control setting — If heater wire mode is selected then the chamber control setting is displayed eg '-1.0'. Not applicable for MR480
- Maximum Heaterplate setting — eg '110'
- Audio Beep

2.4 HEATER WIRE ON MODE (ALL MODELS EXCEPT MR480)

In the Heater Wire On Mode (heater wire switch green LED on) the heaterplate and heater wire are regulated to maintain the desired temperature and humidity, within close limits. To minimise rainout or maximise humidification, the chamber outlet temperature can be adjusted to control at a fixed offset from the set airway temperature. The front panel Chamber Control knob is used for this purpose, see § 2.1.2 above.

2.5 MR730/720 IN HEATER WIRE OFF MODE AND MR480

In the non Heater Wire mode of the MR730/720 (heater wire switch green LED off) the delivery temperature is maintained by heaterplate control only. The sensor at the delivery hose end controls the heaterplate to deliver the selected temperature. The sensor at the chamber outlet is employed in a backup safety mode, to limit the chamber outlet temperature to a maximum of 66 °C. In this way safety at low flow rates (below 5 l/minute) is enhanced at the sacrifice of some low flow performance.

2.6 WARM UP MODE

After initial turn on, warm up mode is entered. In this mode the Low temperature alarm is disabled. The Low temperature alarm is enabled when warm up mode is exited.

2.6.1 WARM UP MODE EXITING CONDITIONS (LOW TEMPERATURE ALARM ENABLED):

- **(MR700/MR730(All versions) and MR720(version 1.0) in Heater Wire Mode)**

Warm Up mode continues until the Software Detects-

Either: The airway temperature reaches within 0.8 °C of the Temperature Control set point.

Or: The airway temperature has not increased by 2 °C for at least 4 minutes (2 minutes for version 3.0 software).

Or: The airway temperature has not got within 2 °C of the set point after ten minutes from switch on.

- **(MR700/MR730(all versions) and MR720(version 1.0) in Non Heater Wire Mode and MR480)**

Warm Up mode continues until the Software Detects-

Either: The airway temperature gets above 30 °C.

Or: The airway temperature has not increased by 2 °C within 15 minutes.

Or: The airway temperature has increased by 2 °C within 15 minutes but still has not reached 30 °C after a further 15 minutes.

Note:In this mode the audio alarm is not enabled until 30 seconds after the Airway Temp Low LED switches on. At this time the heaterplate circuit switches off, pressing mute will silence the alarm for 10 minutes, during which time the heaterplate power is enabled

2.6.2 MR720 (VERSION 2.0, 3.0 SOFTWARE)

If the above warm up exiting conditions are not initially met the MR720 will automatically enter the standby mode for 20 minutes for version 2.0 software and 30 minutes for version 3.0 software (refer § 2.7.2).

2.7 STANDBY MODE

2.7.1 MR700/MR730 (ALL SOFTWARE VERSIONS), MR720 (VERSION 1.0 ONLY)

The standby mode can be entered or exited by depressing the standby button for 1 second. A beep will be emitted once successful entered or exited standby mode (refer § 2.2.3).

In the standby mode all Low Temperature alarms are inhibited, the heaterplate is controlled to a nominal 40.0 °C and the heater wire is on a 15 % duty cycle.

Standby mode is automatically exited after 20 minutes (30 minutes for version 3.0 software) and the warm up mode is entered (the low temperature alarms remain disabled - refer § 2.6).

A Remote Standby request (see Appendix A5.3) enables the standby mode and turns the standby amber LED permanently on.

2.7.2 MR720 STANDBY MODE (VERSION 2.0 AND 3.0 SOFTWARE ONLY)

The MR720 has a special feature where it will go into a standby mode automatically after turn on if the warm up exiting conditions are not met. This standby mode time is 20 minutes for version 2.0 and 30 minutes for version 3.0 software.

While in standby mode, if the airway temperature increases by 2 °C at any time, the MR720 will exit stand by mode and enter warm up mode. The unit then monitors the warm-up exiting conditions(see § 2.6.1 and 2.6.2), and if these are not met, then the unit re-enters Standby mode.

3.0 ALARMS AND INDICATORS

3.1 TEMPERATURE PROBE ALARM

If the airway temperature probe is disconnected or develops a low or high resistance the Temperature Probe alarm will be enabled. Indication is by a '- - -' message on the airway temperature display plus a flashing Temperature Probe red LED and an audio alarm.

Five specific fault types can be diagnosed and are displayed by the sequence of 'decimal points' in the display, as shown below:

a	- - -	Temperature Probe not plugged in.Low temperature (~ 0 °C) Open circuit chamber outlet probe Open circuit in common lead in probe cable.
b	- - -.	Open circuit patient airway probe Very low temperature (~ 0 °C)
c	- -.-	Short circuit chamber outlet probe Very high temperature (~ 100 °C)
d	- -.-.	Short circuit patient airway probe Very high temperature (~ 100 °C)
e	-.- -	Short in probe cable between patient airway probe and chamber outlet probe

The faults (a to d) above are checked for at a rate of about twice per second. The final fault (e) which does not immediately cause any apparent operating anomaly is checked twice a minute.

A Temperature Probe Alarm immediately shuts down both heater wire and heaterplate.

Once the alarm condition has been removed the humidifier will enter warm up mode (refer § 2.6).

3.2 ALARMS IN HEATER WIRE MODE (MR700/720/730 ONLY)

3.2.1 HEATER WIRE ALARM

If the heater wire is disconnected or there is a fault with the heater wire circuit, then the Heater Wire alarm LED will start flashing and the audio alarm will be enabled. Both heater wire and heaterplate circuits will be shutdown. The display will continue to indicate the temperature sensor reading (unless the heater wire fuse is open circuit).

An open circuit heater wire fuse is indicated by 'F-2' appearing on the Airway Temperature display.

On MR720/730 if the Heater Wire is connected but switched off, the alarm will sound (refer § 2.2.4).

Note: If 'F-2' is displayed and the F2 fuse is intact then check the calibration of the 41 °C overheat (refer § 5).

3.2.2 AIRWAY TEMPERATURE HIGH ALARM

The red Airway Temp High LED will flash and an audible alarm will sound if the gas temperature being delivered to the patient is 2 °C higher than the Temperature Control setting. A high temperature alarm instantly disables both heater circuits.

3.2.3 AIRWAY TEMPERATURE LOW ALARM

The red Airway Temp Low LED will flash and an audible alarm will sound if the gas temperature being delivered to the patient is 2 °C lower (4 °C for MR720 model) than the Temperature Control setting. If Airway Temperature Low alarm condition persists for more than 100 seconds the heaterplate and heater wire circuits will switch off. Pressing the mute button will silence the Audio alarm and resume heat for a further 100 seconds, the Airway Temperature Low LED will continue to flash. This alarm is disabled during warm-up. See § 2.6.1.

If the airway temperature drops below 5°C the display will show 'LO' and an audible alarm will sound.

3.2.4 CHAMBER TEMP HIGH ALARM

This alarm will activate if:

- The temperature of gas leaving the humidification chamber outlet is more than 4 °C higher than the chamber set temperature for more than 20 minutes. (The chamber set temperature is the sum of the Temperature Control setting and the Chamber Control setting).
- The temperature of the gas leaving the humidification chamber outlet exceeds the chamber set temperature by 10 °C or more.

This alarm causes the heater circuits to switch off and the 'Chamber Temp High' amber LED indicator to start flashing. The audio alarm (which can be muted) is also enabled. This alarm remains active until the high temperature condition is cleared.

3.2.5 CHAMBER TEMP LOW ALARM ACTIVATION

For Chamber Set Temperature < 35 °C	For Chamber Set Temperature ³ 35 °C
The temperature of gas leaving the humidification chamber outlet is less than 4 °C lower than the chamber set temperature for more than 20 minutes.	The temperature of gas leaving the humidification chamber outlet is less than 31 °C for more than 20 minutes.

The Chamber Temp Low alarm amber LED will begin to flash and the audio alarm is enabled. This alarm remains active until the low temperature condition is cleared. Pushing the mute button will silence the Audio alarm.

3.2.6 SET LOW WARNING

Version 1.0 and Version 2.0 Software

This alarm will activate if the chamber set temperature is below 31.0 °C. In this case the Set Low amber LED will immediately be enabled and remain on, until such time as the chamber set temperature is adjusted above 31.0 °C. There is no audible alarm.

Version 3.0 Software

This alarm will activate if either the chamber set temperature or Temperature Control setting is below 34.0 °C.

In these cases the Set Low amber LED will immediately be enabled and remain on, until such time as the set airway or chamber set temperature is adjusted above 34.0 °C. There is no audible alarm.

3.3 TEMPERATURE ALARMS IN NON HEATER WIRE MODE (INCLUDES MR480)

3.3.1 HEATER WIRE ALARM

This indicates that a heater wire has been connected when the non heater wire mode has been selected (Heater Wire 'On' LED is off). In this case the Heater Wire alarm LED will be flashing, the audio alarm begins and the heaterplate is switched off.

3.3.2 AIRWAY TEMPERATURE HIGH ALARM

The red Airway Temp High LED will flash and an audible alarm will sound if the gas temperature being delivered to the patient is 41 °C or higher. Power to the heaterplate is immediately shut off.

3.3.3 AIRWAY TEMPERATURE LOW ALARM

The red Airway Temp Low LED will flash and an audible alarm will sound if the gas temperature being delivered to the patient is 29.5 °C or less.

The audio alarm is not enabled for 30 seconds after the low temperature LED begins flashing.

Pushing the mute button mutes the audio alarm for ten minutes and restores power to the heaterplate during this time. The Airway Temp Low LED will continue to flash. This alarm is disabled during warmup. See § 2.6.2.

If the airway temperature drops below 5°C the display will show ‘LO’ and an audible alarm will sound.

3.4 AUDIO ALARM

A choice of the ISO draft standard audio alarm or a gliding tone can be selected by the programming control link (L1). Refer Appendix A3.

A momentary depression of the mute button will silence the audio alarm for about 3 minutes (except for a low temperature alarm in no heater wire mode. See § 3.3.3. The relevant LED indicators remain flashing until the alarm condition clears. Any new alarm condition occurring within a mute delay will cause the audio alarm to be re-enabled.

3.5 SAFETY PROTECTION (ALL MODELS)

3.5.1 TEMPERATURE DEVIATIONS

An over temperature alarm condition causes an immediate shut down of both heater circuits. In the case of a Low Temperature alarm, pressing Mute causes heating to recommence, the Low Temperature LED however remains on until the fault has cleared. There are two independent backup over temperature protection circuits.

Firstly, an over temperature protection circuit independent of the microprocessor control continuously monitors the airway thermistor sensor. This backup protection is preset to disconnect the heating circuits at 41.0 °C.Secondly, a bimetallic thermostat fixed to the heaterplate operates if the heaterplate temperature exceeds 118 ± 6 °C and cuts out the mains active supply. On cooling, this protector can only be reset by gaining access to the under surface of the heaterplate and manually depressing the red reset button.

Heaterplate temperature is limited to 110 °C max during normal operation (80 °C for MR720). Optional heaterplate limits of 50, 80 and 90 °C can be selected. (Refer Appendix A3).

3.5.2 MICROPROCESSOR WATCH DOG

A control loop in the operating software continuously monitors for correct operation. Should a fault be detected a hardware reset circuit attempts to reinitialise the microprocessor. If this is not successful additional hardware disables the heating circuit, blanks the display and turns the Humidifier Fault red LED on.

The watch dog circuit is tested at turn on by deliberately halting the processor and forcing initialisation.

4.0 CIRCUIT OPERATION

4.1 INTRODUCTION

This section describes briefly the operation of each of the circuit sections. Refer to the circuit diagrams in § 8.5 to 8.8.

4.2 CONTROL BOARD

The one basic control board, with various discreet hardware changes, provides the controlling functions for the MR730/720/700/480 range of humidifiers. Each model however is controlled by a unique software version.

4.2.1 CONTROL THERMISTORS

Three standard characteristic thermistors control all temperature functions:

- One thermistor is mounted in a probe at the end of the delivery hose to measure delivered airway temperature (connector J4-1,3). This temperature is indicated by the digital display on the humidifier front panel.
- A second thermistor mounted in a probe measures the chamber temperature at the top of the humidifying chamber (connector J4-2,3). In heater wire mode this thermistor is used to monitor and control the chamber outlet temperature.
- A third thermistor is permanently mounted in intimate contact with the heaterplate (HP) (connector J3-1,3). This prevents excessive heaterplate temperatures during a warm up cycle.

4.2.2 INPUT ANALOG SWITCHES U8 AND U9

The 1 by 8 analog switch (U8) selects under processor control (PB0-3) various input signals and reference potentials. Selected sequentially are potentials giving; (0-3): the position of the temperature set potentiometer VR3, and offset potentiometer VR2. (4-6): calibration temperatures of 9, 34.5 and 60 °C across resistors R18, R17 and R16, and from (7): the heaterplate (HP) thermistor.

From the 3 by 2 analog switch (U9) under processor control (PB4-6) the airway temperature and the chamber outlet temperatures from the dual probe temperature sensor are also read.

4.2.3 ANALOG TO DIGITAL CONVERTER U10 B,D,E

The temperature probe inputs are filtered by the C30, C31, R28, R26, C19, C20 network for EMI suppression. The selected output of the analog switch network U8, U9 is fed to pin 10 of U10d, a low pass operational amplifier with a gain of 11. This stage is filtered with C23 to give protection from any voltage transients appearing at its input. The integrating stage U10b rests for most of the time (50 to 60ms) with R35 connected (through an analog switch in U9) across the integrating capacitor C22 holding it in a discharged state. With VR5 and R34 connected to the non-inverting input of U10b the stage has a ‘static' gain of about 0.5 giving a resting level of about -2.5 to -3 V at the output pin 1.

Under processor control (PB6) when the switch section of U9 across C22 is opened the output of U10b ramps up (0.1-5 ms). This rising ramp voltage is fed via R36 to the comparator stage U10e where it is referenced via R41 to the output voltage level of U10d. When the ramp voltage exceeds the threshold level of U10d the output of the comparator stage U10e switches high. This fast rising edge, assisted by the speed up capacitor C24, is fed to the RST 6.5 interrupt input of U3.

4.2.4 PROCESSOR CONTROL U3

After selecting one of the 10 input signals through the switch network of U8, U9 there is a 50 to 60ms pause to allow U10d to settle. At this point the switch across the integrator U10b is opened initiating a linear ramp output and the 14 bit counter in U4 is started. Within a time period of 100 ns to 5 ms the ramp will cause a RST6.5 interrupt to occur. The processor on responding to the interrupt, first stops the counter, then closes the switch across the integrator readying it for the next cycle. The input switch network U8, U9 can now be stepped to the next input. The 14 bit counter can now be read and its value equated to the input signal. In this way all 10 input channels are continuously scanned. VR5 is set

during calibration to give the desired ramp rate. Thus all points are scanned once every 500 to 600 ms, self calibration performed, and the digital display updated.

4.2.5 POWER LINE INTERRUPT (REVISIONS D/F PCBS)

A sample of the power supply frequency is derived from the power transformer 22 Vac secondary via R56 and Q1, buffered by Schmitt trigger U5f and fed to the RST7.5 interrupt of U3. The operating software determines the supply frequency facilitating the generation of a real time clock and also enabling a zero crossing detector for triac switching. The ADC is also phase synchronised with the line frequency thus eliminating any common error from this source.

4.2.6 POWER LINE INTERRUPT (REVISION H PCB AND LATER)

The zero crossing is derived from the 10 Vac secondary. Resistor R61 ensures that the secondary is ground referenced when the diodes D13 to D16 are not conducting. Network R1, R69, and C2 removes any unwanted noise from the zero crossing circuit. The operating software determines the supply frequency facilitating the generation of a real time clock and also enabling a zero crossing detector for triac switching. The ADC is also phase synchronised with the line frequency thus eliminating any common error from this source.

4.2.7 41 °C COMPARATOR

Operational amplifier U10c is a protection circuit to sense excessive delivery temperature rise. The non inverting input pin 5 is connected directly (via connector J4-1) to the patient airway thermistor. The inverting input goes to an adjustable divider network R32, VR4, R33. VR4 is set during calibration to ensure that the output pin 7 of U10c is low above an input temperature of 41 °C. This low output (OVHT) is fed via the isolating diode resistor networks D19, R55 and D20, R61 to clamp the bases of switching transistors Q10 and Q12. In this way, a patient airway temperature greater than 41 °C causes both heaters to be shut down.

A watch dog failure, which is a high output from U5g, is communicated via isolating diode D11 and resistor R31 to the inverting input of U10c. This also ensures that both heater control circuits are clamped off in the event of a processor crash.

4.2.8 HEATERPLATE OVERTEMPERATURE

Thermistor HP senses the heaterplate temperature. Should the heaterplate exceed the maximum heaterplate limit (default 110 °C) during normal operation, power to the heaterplate is discontinued until it cools below this limiting temperature. Under certain operating conditions, for increased safety, lower maximum heaterplate temperatures can be selected. (See Appendix A3: Programming Control Options.) Also mounted on the heaterplate is a mechanical 118 °C cut out which will give protection should the electronic control system fail. This mechanical cut out is connected in series with the power transformer primary and thus causes complete shut down of the humidifier should a serious fault develop. See § 3.5.1.

4.2.9 WATCH DOG

During operation the processor is continually monitored for correct function. This is done by changing the state of output port PB7 of U4 every 16.6 or 20 ms (power line frequency interrupt). This square wave, buffered by U5b, is fed to the charge pump circuitry C16, D4, D5 and C15 which ensures that pin 13 of U5g is held hard up. Should this square wave be interrupted for any reason, C15 will discharge through R3 giving a high output from pin 12, which drives the trap interrupt input of U3. This high trap input forces re-initialisation of the processor which may or may not be successful depending on the nature of the fault. The purpose of this is to ensure that if the processor should fail, and is unable to re-initialise, it fails in a safe mode. The watch dog circuit is tested every time the humidifier is turned on by deliberately halting program execution and waiting for initialisation via the watch dog. To indicate that the processor has failed the high output of U5g also turns on Q3 which lights the ‘see manual’ LED10 and also turns off the display I.C. U7 to blank the digital display.

4.3 POWER BOARD

4.3.1 REVISION D/F PCBS

A bridge rectifier (D13 to D16) supplies power to the 5 V regulator Q7 mounted on the heat sink. This circuit is protected by a 1 A fuse (F1) mounted on the circuit board. The 5 V negative supply stabilized by Q8, is derived from the voltage doubling network D17, D18.

The Heater Wire (HHC) is controlled by triac Q9 which is mounted on the heat sink. Q9 is switched by the optoisolator U11 which in turn is driven by Q10. Q10 is controlled directly from an output port of U4 on the control board.

The resistor R52 connected to the anode of Q9 provides a signal through (HHS) to U5d and U4. This signal, with processor interpretation, provides the information to determine if the Heater Wire is connected or open circuit and also the integrity of fuse F2, the 4 A fuse supplying power to the Heater Wire.

Triac Q11 (mounted on the heatsink) is controlled by optoisolator U12, which in turn is controlled by Q12, and HPC.

Transistors Q5 and Q6 are a RS232 level driver for the serial data interface.

4.3.2 REVISION H AND J PCBS

A bridge rectifier (D13 to D16) supplies power to the 5 V regulator Q7 mounted on the heat sink. This circuit is protected by a 1 A fuse (F1) mounted on the circuit board. The 5 V negative supply stabilized by Q8, is derived from the voltage doubling network D17, D18.

The Heater Wire (HHC) is controlled by triac Q9 which is mounted on the heat sink. Q9 is switched by the optoisolator, U11, which in turn is driven by Q10. Q10 is controlled directly from an output port of U4 on the control board (HHC). Resistor R9, C6 form a snubber on the triac. Capacitors C8, C32 balance the heater wire with respect to ground.

Heater wire sensing is accomplished through the optoisolator U13 and associated components R51, R52, D21, R66 and R67. R51 and R52 limit the current through the LED when the triac is on or off. With the triac off and a heater wire connected then the optoisolator will remain off. Otherwise if a heater wire is not connected then the optoisolator will be turned on and off in synchronisation with the secondary cycle. The output of the optoisolator feeds U4 on the control board. This signal, with processor interpretation, provides the information to determine if the Heater Wire is connected or open circuit and also the integrity of fuse F2, the 4 A fuse supplying power to the Heater Wire.

Q11 controls power to the heaterplate and is under control of optoisolator U12 and transistor Q12 via an output port (HPC) on U4 on the control board. Resistors R64, R57 limit the gate current to the triac and with C33 form a snubber for the triac and the optoisolator.

Transistors Q5 and Q6 are an RS232 level driver for the serial data interface.

4.4 PROBE TEMPERATURE VERSUS THERMISTOR RESISTANCE

TEMP (± 0.2 °C)	**RESISTANCE** (Ω)	**TEMP** (± 0.2 °C)	**RESISTANCE** (Ω)
0	7352.8	36	1411.3
9	4702.2	37	1355.0
28	1976.6	38	1301.0
29	1893.3	39	1249.2
30	1814.4	40	1199.6
31	1739.2	41	1152.3
32	1667.2	42	1107.3
33	1598.2	43	1064.5
34	1532.9	44	1023.1
35	1470.6	60	560.3

5.0 CALIBRATION

5.1 INTRODUCTION

Calibration should be performed after any servicing involving the printed circuit boards. After calibration, perform a performance check as outlined in § 6.0.

Note: For instructions on disassembly of the unit, refer to § 7.0.

Calibration is facilitated by entering a special Calibration mode. See Appendix A1.

There are only two adjustments VR4 (the 41 °C comparator stage) and VR5 (setting of the span of the A to D converter).

This calibration procedure may be carried out if the unit is thought to be out of calibration (E0x to E7x error messages in the display) or if any of the circuit boards have been replaced or repaired. In particular any repair that may have altered the potential of the ± 5 V rails or component change associated with the A to D converter would require a calibration check.

Calibration should be checked and performed after the unit has been running for at least twenty minutes; ie after the unit has warmed up.

5.2 EQUIPMENT REQUIRED

- 41 °C calibration probe, available in MR700 series calibration kit (Fisher & Paykel part no. 900MR548).

For models with Revision D PCB and earlier:

- Heater Wire module.
- For MR480 only - jumper connector cable, which consists of two easy hooks connected in series with a 100mm length of cable and a 22 kΩ resistor.

5.3 CALIBRATION PROCEDURE FOR MODELS WITH REVISION D PCBS OR EARLIER

(Before Serial Number 92XXAAA05495) (See § 9.0 for change history).

1 With models MR730/720/700 ensure that a Heater Wire module is connected, and that the Heater Wire switch is on (Heater Wire On LED should be on).

2 Plug in the 41 °C calibration probe.

3 Gain access to the adjustment potentiometers VR4 and VR5, by removing the control board from the humidifier front panel.

4 With model MR480 only connect the jumper cable from pin 7 of U10 to the cathode end of D7 on the control board.

5 With the Chamber Temp button held down turn on the power switch. Display should show -1-

6 Using the Chamber Temp button step through to number -4-

7 Adjust VR4 slowly so the display just changes from vertical to horizontal bars (|||||| to ===). Back off VR4 and recheck that VR4 is not rotated past this display transition point.

8 Using the Chamber Temp button step to number -5-

9 Remove the 41 °C calibration probe.

10 Adjust VR5 for a display reading of zero. (0)

(This value may drift over time. A deviation of up to ± 2.0 will not affect circuit performance.)

11 Calibration is complete; do performance check (§ 6.0).

5.4 CALIBRATION PROCEDURE FOR MODELS WITH REVISION F PCBS OR LATER

(See § 9.0 for serial number details)

1 Plug in the 41 °C calibration probe.

2 Gain access to the adjustment potentiometers VR4 and VR5, by removing the control board from the humidifier front panel.

3 With the Chamber Temp button held down turn on the power switch. Display should show -1-

4 Using the Chamber Temp button step through to number -4-

5 Starting with a vertical bar display adjust VR4 so the display changes to an all **8** display. If VR4 is rotated too far the display becomes all horizontal bars (||.||.||. thru **8**.**8**.**8**. to ===). The correct point is where all the segments of the all **8** display are of equal brightness.

6 Using the Chamber Temp button step to number -5-

7 Remove the 41 °C calibration probe.

8 Adjust VR5 for a display reading of zero. (0)

(This value may drift over time. A deviation of up to ± 2.0 will not affect circuit performance.)

9 Calibration is complete; do performance check (§ 6.0)

6.0 PERFORMANCE CHECK

6.1 INTRODUCTION

This procedure should be used to check the operation and calibration of the MR730/720/700/480. This performance check should be performed after any servicing, and annually as part of the routine maintenance procedure (see Appendix B).

Performance can be monitored during the test by using the functions of the Engineering Menu. See Appendix A2.

If there is a desire to confirm the full dynamic operation of the Humidifier, such as after servicing, a full test of the temperature control of the Humidifier may be performed, see tests detailed in Addendix E.

6.2 PERFORMANCE CHECK MR730/720/700

6.2.1 EQUIPMENT SETUP NOTES:

- 34.5 °C and 41°C test probes, available in MR700 series calibration kit (Fisher & Paykel part no. 900MR548).
- A heated wire breathing circuit of any length, single use or reusable.(If a single use circuit is used, ensure there is a gas flow through it of at least 2 l/minute to prevent overheating of the circuit.)
- Heater wire adaptor for connection to a MR700 series humidifier
- A Humidification Chamber filled with water to recommended level (water at room temperature.)
- A temperature probe is not used in the circuit in this test.

6.2.2 SETUP

1 Connect the heated circuit to the humidifier , ensure the circuit is not covered to prevent overheating of the tubing. ***Remember there must be an airflow of at least 2 l/min for single use circuits.***

2 Plug in the 34.5 °C test probe to the humidifier.

3 Slide the humidification chamber on to the humidifier.

4 Plug in the humidifier and turn the power on. For the MR720 and MR730, ensure the heater wire switch is ‘on’ (heater wire LED will light).

6.2.3 TEMPERATURE CONTROL CHECK MR700/720/730

1 Turn the Temperature Control knob to 33.0 ± 0.2 °C and Chamber Control to 0. (Note the Temperature Control and Chamber Control settings will be displayed as the control knobs are adjusted.

2 Check the display reads 34.5 ± 0.2 °C and that the ‘Set Low’ warning light is on (units with version 3 software only).

3 Push the Chamber temp. button and check for a 34.5 ± 0.2 °C reading on the temperature display.

4 Run for 5 minutes without interruption.

5 After 5 minutes Check:
Heaterplate is warm or cold.(Less than 60 °C , see ‘hP’ in the engineering menu).
Heater Wire cold (feel the wire or circuit, should be cold to touch).

6 Turn the Temperature Control knob to 36.0 ± 0.2 °C and leave Chamber Control set at 0.

7 Run for at least 20 minutes without interruption.

8 After 20 minutes Check:
Heaterplate hot (Greater than 80 °C, see ‘hP’ in the engineering menu.
Heater Wire hot (feel the wire or circuit, should be warm to touch).

CAUTION: THE WATER IN THE CHAMBER MAY BE NEAR BOILING AT THIS STAGE

6.2.4 ALARMS CHECK MR700/720/730

1 Rotate Temperature Control knob to 37 and check for an Airway Temperature Low alarm. (For an MR720 set to 40 °C and check for an Airway Temperature Low alarm).

2 Rotate Temperature Control knob to 32 and check for an Airway Temperature High alarm.

3 If 'set low' light is not already on, rotate the chamber control to -1.5 and check that the 'set low' light comes on (all software versions).

4 Rotate the Temperature Control knob back to 36 and check that alarms cease and set low LED is off..

5 Disconnect the Heater Wire plug and check for audio alarm and Heater Wire alarm light.

6 Reconnect the heater wire. For MR720/730 models, turn the Heater Wire off and check for audio alarm and Heater Wire alarm light.

7 Disconnect the 34.5°C temperature probe and check that the Temperature Probe LED flashes and gives an audio alarm.

8 Insert the 41°C temperature probe into the humidifier and check that the Airway Temperature High LED flashes and the audio alarm sounds.

9 Push the Mute button and check that the audio alarm is silenced

10 Go to the engineering menu and check that the heaterplate duty cycle (Cdc) and heater wire duty cycle (Edc) are starting to decrease, this may take a few seconds.

11 Turn off the humidifier.

12 Humidifier is now ready for service.

6.3 PERFORMANCE CHECK (MR480)

6.3.1 EQUIPMENT REQUIRED

- 34.5 °C and 41 °C test probes, available in MR700 series calibration kit (Fisher & Paykel part no. 900MR548).
- A **Full** Humidification Chamber

6.3.2 SETUP

1 Slide the humidification chamber on to the heaterbase.

6.3.3 TEMPERATURE CONTROL CHECK (MR480)

1 Plug in the 34.5 °C test probe.

2 Turn the Temperature Control knob to 32.0 °C.

3 Turn on the humidifier main power switch.

4 Check that 32.0 ± 0.2 °C flashes on the display during initialisation.

5 Check for a display reading of 34.5 ± 0.2 °C after initialisation.

6 Push the Chamber Temp. button and check for a reading of 34.5 ± 0.2 °C.

7 Run for 5 minutes without interuption. If mains power is interupted test will have to be restarted.

8 After 5 minutes check the following in 'Engineering mode' (see Appendix A2):

Set 32
hp ≤ 60

9 Turn off the humidifier.

10 Turn the Temperature Control knob to 36.0 ± 0.2 °C (check correct setting is displayed when the control is adjusted).

11 Run for 25 minutes.

12 After 25 minutes check the engineering menu (appendix A2.2):

Set 36
hp ≥ 70

6.3.4 ALARMS CHECK - MR480

1 Disconnect the 34.5°C temperature probe and check that the Temperature Probe LED flashes and gives an audio alarm.

2 Insert the 41°C temperature probe into the humidifier and check that the Airway Temperature High LED flashes and the audio alarm sounds.

3 Push the Mute button and check that the audio alarm is silenced

4 Go to the engineering menu and check that the heaterplate duty cycle (dc) is starting to decrease, this may take a few seconds.

5 Turn off the humidifier.

6 Humidifier is now ready for use.

6.4 DUAL PROBE TEMPERATURE TEST

This test is recommended to be performed on all temperature probes every three months or if there is any doubt as to the accuracy of the temperature probe. This test allows the operator to compare the temperature readings of both probes (chamber and airway) firstly to one another, and secondly to a glass thermometer for absolute verification of temperature if so desired. (Using a water bath and thermometer is the most reliable method to check the temperature probe accuracy.)

6.4.1 EQUIPMENT REQUIRED

- Dual Temperature probe to be tested.
- Glass thermometer accurate to ±1°C.
- Cup of warm water (Ambient to 40 °C).
- Heater wire if using humidifier in heater wire mode.

6.4.2 TEST PROCEDURE

1 Plug the dual probe plug into the Humidifier, if in Heater Wire mode ensure a heater wire assembly is connected.

2 Turn on the mains power.

3 Insert both temperature probes into a container filled with water at a temperature between ambient and 40 °C. As temperature gradients can be quite large it is recommended that the two probes be held together with a rubber band during this test and the water constantly stirred.

4 Place the thermometer in the water alongside the probes and allow two minutes for the temperatures to stabilise. It is recommended that the water be constantly stirred during this test.

5 Enter the Engineering menu (refer Appendix A2) and select ‘CP’ (compare probes) option. The display will alternate between the airway and chamber temperatures (chamber temperature is displayed with all decimal points turned on).

6 Check the temperature difference between chamber and airway probes as indicated by the display, it should not exceed 1.5 °C.

7 Ensure that the temperature reading of the chamber and airway probes are both within 1.5 °C of the thermometer reading.

7.0 SERVICING INFORMATION

7.1 INTRODUCTION

This section provides information for servicing the MR730/720/700/480 Humidifier. The electronic circuitry is contained on two separate circuit boards, the power board and control board.

Please note the following:

- Follow ESD precautions when handling circuit boards.
- After replacing or modifying a circuit board, go through the calibration and performance tests outlined in § 5 and 6.
- After any repair involving opening of the humidifier, go through the electrical safety tests outlined in Appendix B2.
- When replacing any screws, refer to torque settings in § 7.6.

7.2 PRINTED CIRCUIT BOARD REMOVAL

7.2.1 CONTROL PCB

The front panel and heaterplate assembly is separated from the humidifier body by removing the 4 fixing screws from the rear of the humidifier body. The front panel assembly can now be moved aside and the two ribbon cable connectors (J1 and J2) disconnected from the rear of the control board. If the front panel is now positioned face down the three plastic retaining latches protruding through the board can be moved in the appropriate direction to release the board. This is facilitated if a slight upward finger pressure is maintained on either edge of the board, when the latches release, the board will pop up leaving the push on control knobs behind in the front panel.

7.2.2 POWER PCB

Separate the case front from the humidifier body and disconnect the two ribbon cable connectors joining the Power PCB and Control PCB (J1 and J2). Cut the cable tie holding the heaterplate and chassis wires together.

The power board and heat sink assembly can now be removed by flexing the case sides away from the top edge of the board and moving the board forward slightly to disengage from the case. The board should now be lifted slightly to clear the lower retaining guides and moved further forward to gain access to the various wiring harness connectors which can now be detached. Before removing the PCB, unscrew the mains cord connections and cut the cable tie holding the mains cord in place.

7.3 COMPATABILITY

7.3.1 HARDWARE COMPATABILITY

- If a revision D or earlier power or control PCB needs to be replaced, then both PCBs need to be upgraded together to ensure correct performance. Revision F and later PCBs can be replaced individually.
- To upgrade both PCBs and the software use a PCB service upgrade kit. The part numbers to order are as follows:

Model	Part number	Model	Part number
MR480	043040791	MR720	043040793
MR700	043040792	MR730	043040794

- For humidifiers with Rev F or later PCBs, you will only be required to purchase individual boards for repairs (as detailed in sect. 8.9).
- If a revision H or later power PCB needs replacing, the replacement power PCB must also be revision H or later.

Replacing revision F or earlier power PCB MR700/720/730

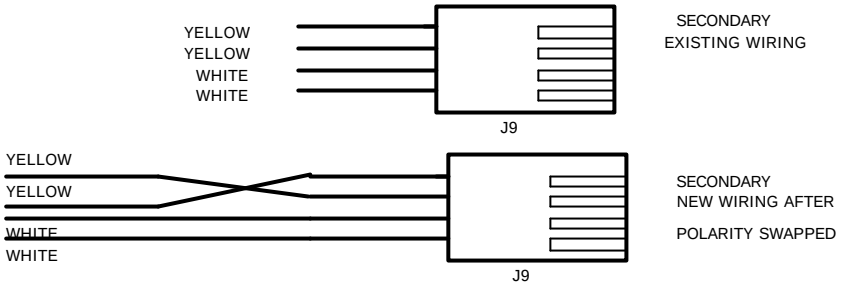
If you are fitting a ***Revision H or later power PCB*** to a Humidifier that has a ***revision F or earlier control PCB*** , you will have to ensure correct phase polarity on the transformer secondary wires. To check for correct polarity, turn the humidifier on, if the humidifier displays F-2, then the polarity of one of the transformer secondaries needs to be changed.

This is accomplished as follows:

i. Unplug the power supply and then unplug the transformer secondary connector (Connector J9) from the power PCB.

ii. Then carefully remove the two yellow wires from the connector housing by depressing the locking tabs on the back of the connector terminals and pulling the wires out of the housing.

iii. Insert the yellow wires in to the connector housing in reverse order to what they were before. See below.



Replacing revision F or earlier power PCB MR480

If the existing power PCB is Rev. F or earlier, there will be an earth wire from the secondary harness of the transformer to the chassis. Unclip this wire from the transformer connector and unscrew it from the chassis. The Rev. J replacement power PCB will have an earth wire attached to the PCB. Fit the end of this earth wire to the earth stud on the chassis.

7.3.2 MR480 TRANSFORMERS

For MR480's , the transformer secondary wiring changed when Rev. J PCB started. When replacing the transformer, follow the instructions supplied in the transformer replacement kits to ensure compatability.

7.3.3 SOFTWARE COMPATABILITY

Software versions 1.0 and 2.0 can be upgraded to version 3.0 in their existing PCBs.

Software version 1.0 should be replaced with version 3.0 if the PCB's are upgraded. Software versions 2.0 and 3.0 are compatable with all PCB revisions.

7.4 HEATERPLATE

To reset the 118 °C over temperature cutout, separate the case front from the case body, then push the reset button (through a small hole under the heaterplate in the front panel case assembly).

To replace the heaterplate:

1 Separate the case front from the humidifier body.

2 Unclip the Power PCB from the case body (see § 7.2.2 above).

3 Unplug the heaterplate wires from the Power PCB (connectors J3 and J7).

4 Unscrew the earth screw on the chassis for the heaterplate earth wire.

5 Unplug the ribbon cables from the Power PCB to the Control PCB (connectors J1 and J2). The front case assembly is now separate from the case body.

6 Detach the heaterplate from the case front by unscrewing the three screws which secure it to the case front.

7 Assembly is the reverse of the above procedure.

7.4.1 HEATERPLATES WITH SCREW-IN STANDOFFS

For products after S/N:9773XXX19731, the heaterplate standoffs were changed to shoulder bolts that screwed directly into the heaterplate.

When fitting these heaterplates,'click' the heaterplate springs into the recesses on the heaterplate (by rotating them while pushing down), then align the springs with the holes in the case front and screw in the self tapping standoffs into the heaterplate.

7.5 FAULT LOCATION

If neither the digital display nor any of the front panel LED's are on and no power appears to be reaching the transformer primary, check that the mechanical overheat protector on the heaterplate has not cut out. This may be checked by depressing the red reset button. (See § 7.4).

Determine if all power supplies are operational and all fuses are intact. If the power supplies are OK but the display is blank, check the watch dog output (pin 12, U5g). A high output here will blank the display, turn on the humidifier fault LED indicator and isolate the heater circuits but not necessarily stop the processor. Check for the presence of a 33 to 40 ms period square wave at PB7 (pin 1 U5b). If the watch dog output is high and the 33 to 40 ms clock is present a fault in the watch dog circuitry is indicated but if port PB7 is not changing state there is a fault elsewhere.

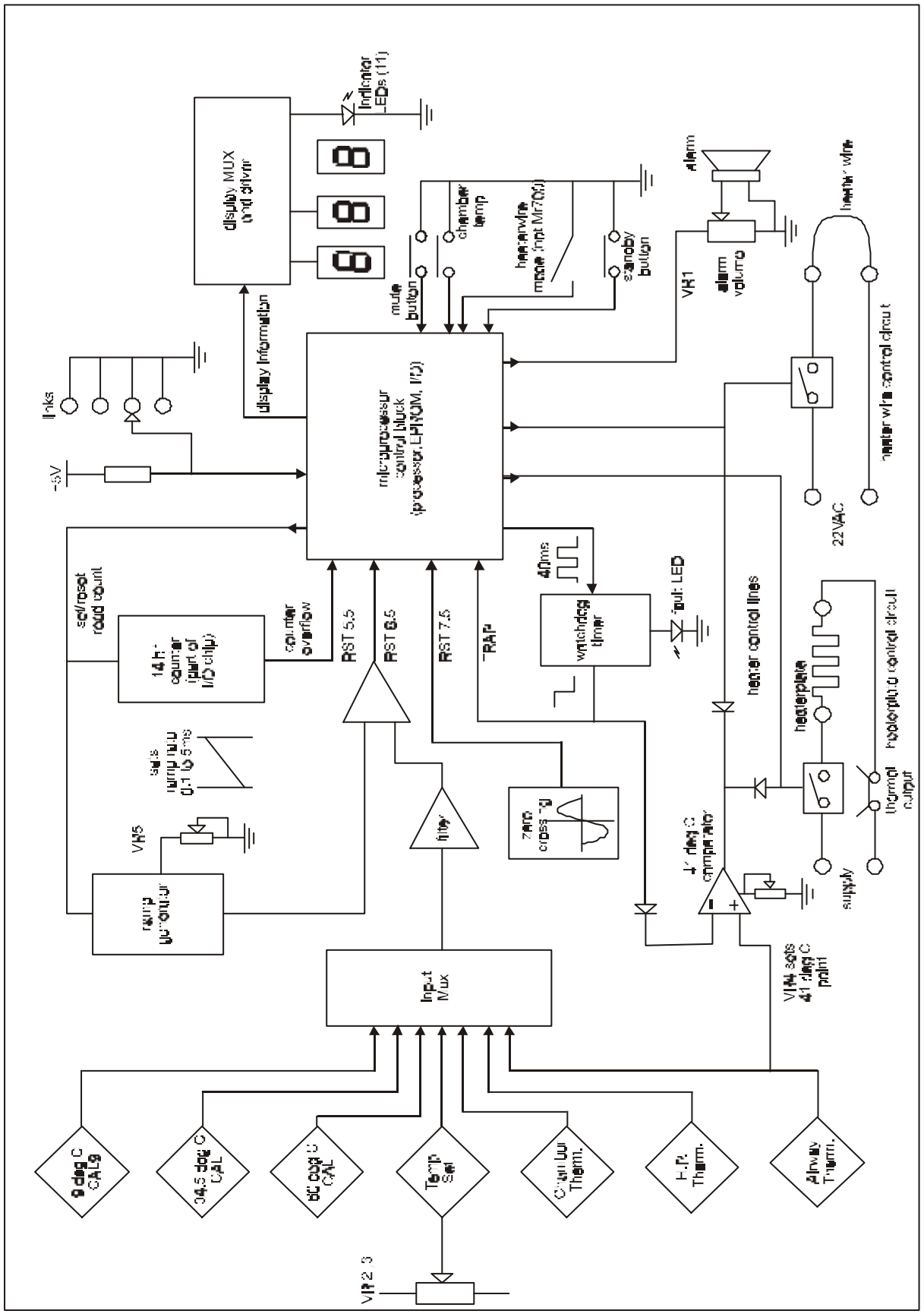
7.6 SCREW TORQUE SETTINGS

Below is a guide to screw torques used on the humidifier, use this as a guide for tightening of screws on the humidifier (exact torques are not required).

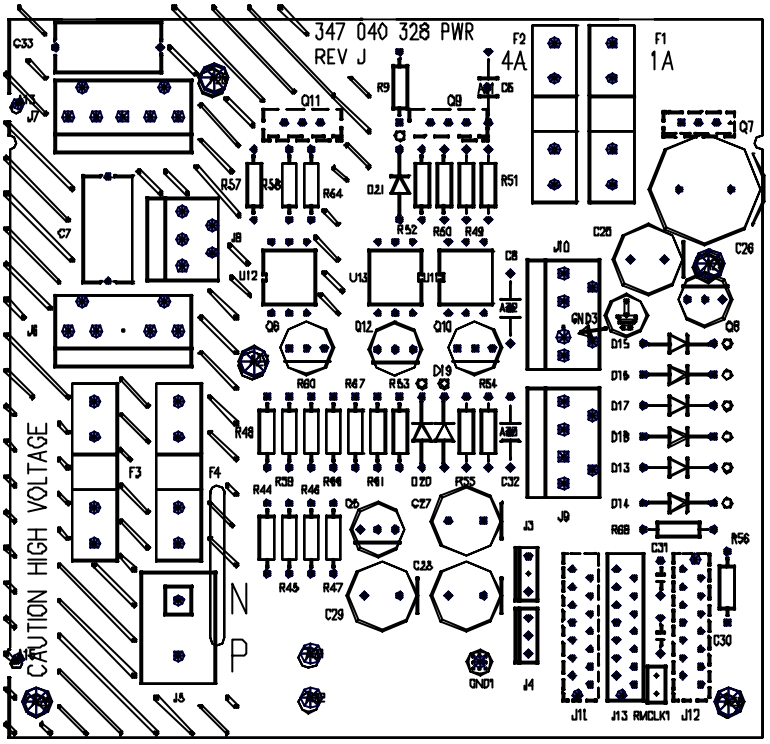
Ref	Screw	Application	Driver	Torque(in/oz)	Torque (Nm)
	CHASSIS				
14	Screw #8 x ½ Pan Phil TY25 S/S	Case Front/Body	Phillips	85-113	0.6 to 0.8
18	Screw M4 x 8 Pan Phil Taptite	Chassis Earth Screws	Phillips	240-270	1.7 to 1.9
21	Screw M6 x 25 Csk Allen S/S	Mounting Bracket	Allen	248-276	1.75 to 1.95
22	Screw M4 x 14 Pan Pozi Taptite	Mains Cord Clamp	Pozidrive	198-240	1.4 to 1.7
26	Screw M6 x 16 Allen S/S Button Head	Chassis Earth Screw	Allen	248-276	1.75 to 1.95
27	Screw M3 x 5 Pan Phil Taptite	Heaterplate Standoffs	Phillips	99-113	0.7 to 0.8
	HEATERPLATE				
2	Screw M4 x 8 Pan Phil Taptite	Heaterplate Earth/Element	Phillips	212-254	1.5 to 1.8
5	Screw M3 x 5 Pan Phil Taptite	Thermistor/Thermostat Heaterplate	Phillips	99-113	0.7to 0.8

8.0 SCHEMATICS, PART LISTS AND MECHANICAL DRAWINGS

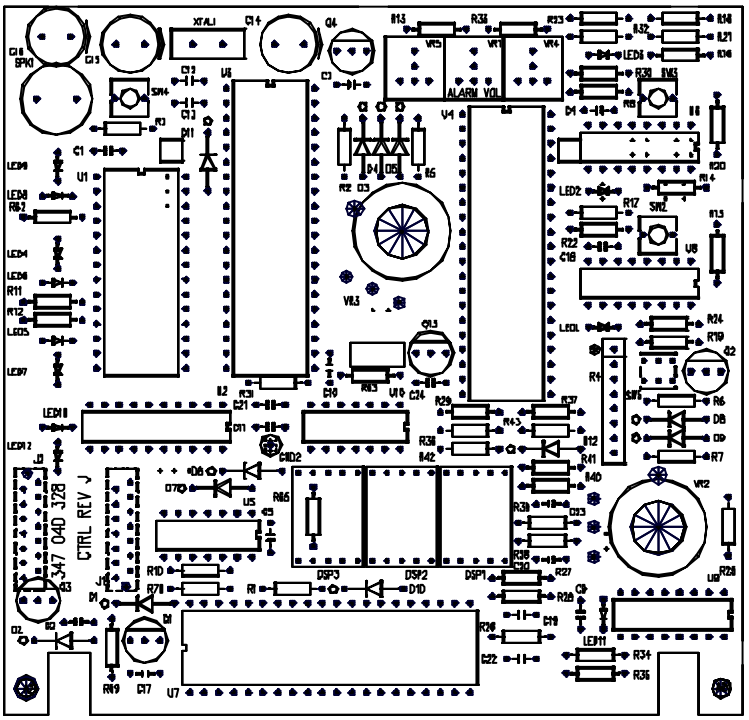
8.1 MR700 SERIES CIRCUIT LAYOUT BLOCK DIAGRAM



8.2 COMPONENT LAYOUT - REVISION H AND J PCB

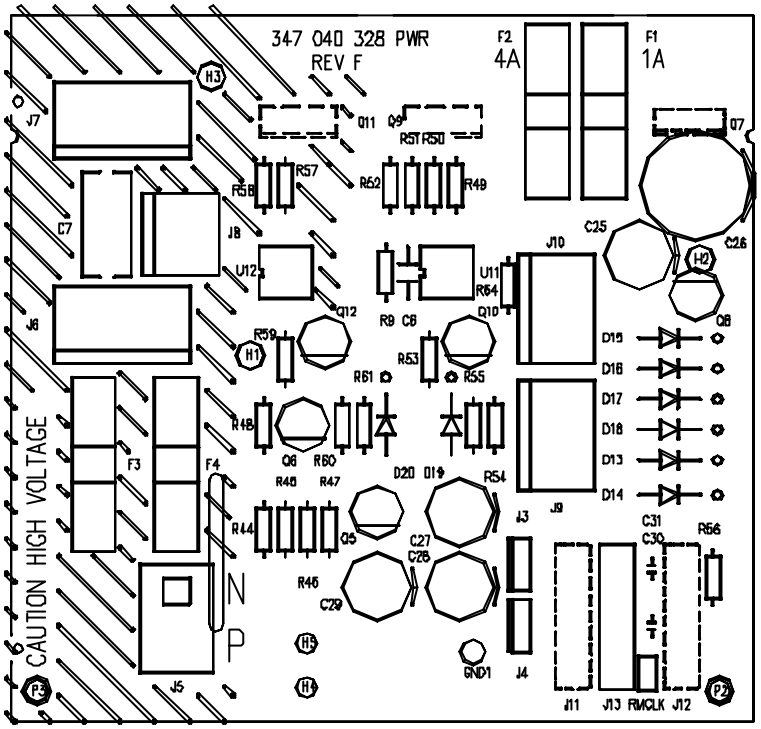


Power Board

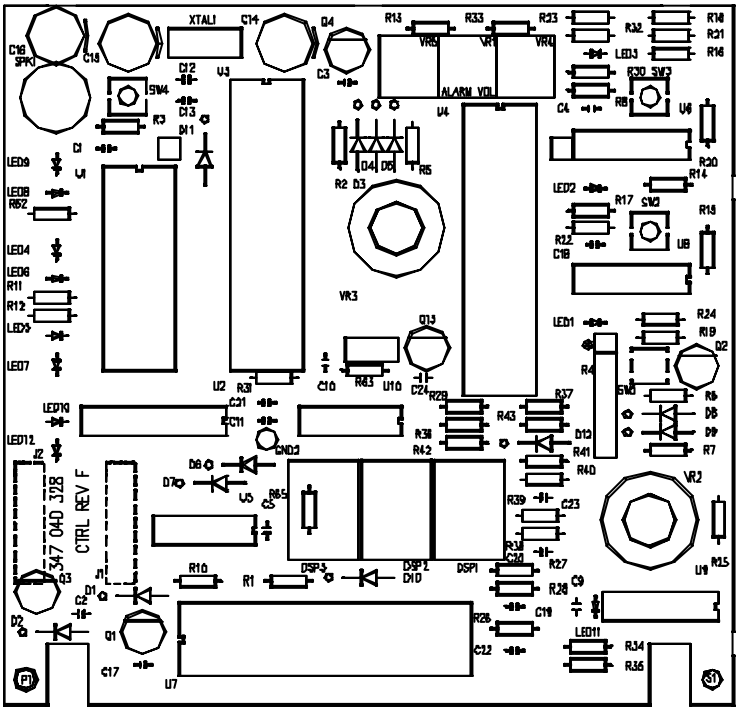


Control Board

8.3 COMPONENT LAYOUT - REVISION F PCB

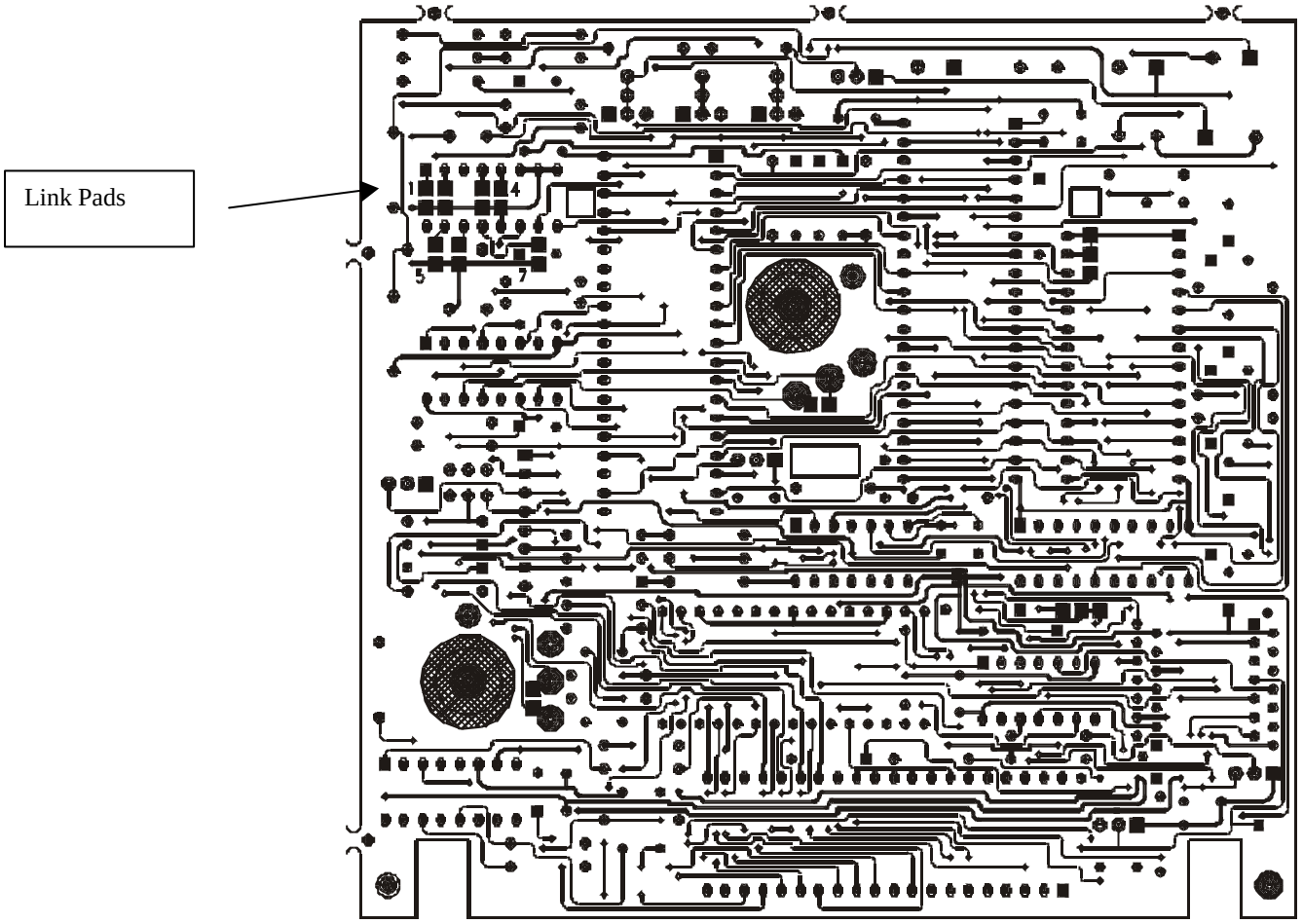


Power Board



Control Board

8.4 LINK PAD LOCATIONS FOR PROGRAMMING CONTROL OPTIONS - REVISION H AND J PCB



Control Board(viewed from solder side)

Location of Link Pads for Programming Control Options (see Appendix A3)

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8.5 CIRCUIT DIAGRAMS - REVISION H AND J PCB CONTROL PCB

8.6 CIRCUIT DIAGRAMS - REVISION H AND J PCB POWER PCB

8.7 CIRCUIT DIAGRAMS - REVISION F PCB CONTROL PCB

8.8 CIRCUIT DIAGRAMS - REVISION F PCB POWER PCB

8.9 ELECTRICAL PARTS LIST

The electrical components listed below are referenced in accordance with the component layout and the circuit diagrams (see § 8.2 to 8.8).

Note: The Control and Power PCB Assemblies listed below are replacement parts for Revision F & later PCBs. For replacement of Revision D PCBs refer to § 7.3 for details of upgrade kits.

8.9.1 CONTROL BOARD COMPONENTS: (REVISION H AND LATER PCBS)

Ref	Description	Part No.
	Control PCB Assembly MR480 (No Eprom)	043040679
	Control PCB Assembly MR700 (No Eprom)	043040633
	Control PCB Assembly MR720 (No Eprom)	043040677
	Control PCB Assembly MR730 (No Eprom)	043040675
	Eprom Programmed MR480 Ver 3.0	362040076
	Eprom Programmed MR700 Ver 3.0	362040077
	Eprom Programmed MR720 Ver 3.0	362040078
	Eprom Programmed MR730 Ver 3.0	362040079
C1, C3, C4, C5, C9, C10, C11	Cap. Ceramic 100 nF 50 V	312040153
C2	Cap. Mylar 100 nF 50 V	316040085
C12, C13	Cap. Ceramic 22 pF 50 V	312040130
C14, C15, C16	Cap. Elec. 10 µF 25 V	311040663
C17	Cap. Ceramic 1 nF 50 V	312040107
C18, C19, C20	Cap. Ceramic 22 nF 50 V	312040116
C22, C23	Cap. Mylar 10 nF 50 V	316040084
C21, C24	Cap. Ceramic 470 pF 50 V	312040118
D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12	Diode 1N4148	361040155
DSP1, DSP2, DSP3	Display LED (HDSP5301 or LA6760)	999860001
J1A, J2A	14 pin ribbon connector socket	341040357
LED1, LED3	LED green	361040329
LED2,LED4, LED5,LED11	LED amber/yellow	361040328
LED6,LED7, LED8,LED9,LED10	LED red	361040327
Q1, Q2, Q3, Q4, Q13	Transistor BC547B	361040159
R1, R2, R3, R5, R6, R14, R26, R28, R31, R36, R39, R41, R43	Resistor 10k 0.25 W 5%	325040284
R4	Resistor DIL Resistor pack 7/27k 5%	325046010
R7, R13	Resistor 4k7 0.25 W 5%	325040287
R8	Resistor 27k 0.25 W 5%	325040319
R10, R33, R65, R70	Resistor 22k 0.25 W 5%	325040318
R11	Resistor 180E 0.25 W 5%	325040309
R12	Resistor 6k8 0.25 W 5%	325040335
R15	Resistor 9k09 0.25 W 1% Metal Film	325040145
R16	Resistor 560E 0.25 W 0.5% Metal Film	325040135
R17	Resistor 1k5 0.25 W 0.5% Metal Film	325040137
R18	Resistor 4k7 0.25 W 0.5% Metal Film	325040138
R19, R24, R69	Resistor 2k2 0.25 W 5%	325040282

R20	Resistor 412E 0.25 W 0.5% Metal Film	325040152
R21, R22, R23, R27, R29	Resistor 820E 0.25 W 0.5% Metal Film	325040136
R25, R35, R40	Resistor 100k 0.25 W 1% Metal Film	325040139
R30	Resistor 220E 0.25 W 1% Metal Film	325040134
R32, R63	Resistor 15k 0.25 W 5%	325040317
R34	Resistor 180k 0.25 W 1% Metal Film	325040125
R37, R38	Resistor 22E 0.25 W 1% Metal Film	325040133
R42	Resistor 2k7 0.25 W 5%	999012720
SW2, SW3, SW4	Push Switch	349040094
SW5	Heater Wire Switch	349040099
SPK1	Audio Transducer CB-12KP	426040015
U2	IC Octal Latch 74LS373	999610004
U3	IC Micro-Processor 8085	999630012
U4	IC Ram I/O Timer 8156	999630003
	or IC Ram I/O Timer 81C55	363040415
U5	IC Hex Inverter 74HC14	363040232
U6, U8	IC 8 Channel Mux. CD4051B	363040125
U7	IC Display Driver MM5451N	363040126
U9	IC 3×2 Channel Mux. CD4053B	999610003
U10	IC Quad Operation Amplifier TL074	363040124
VR1	10k Preset	327041591
VR2, VR3	5k Potentiometer	327041562
VR4	10k Preset Multiturn	327041565
VR5	50k Preset	327041590
XTAL1	Crystal 6.14 Mhz	999820001
	Spacer Heater Wire Switch	693040522

8.9.2 POWER BOARD COMPONENTS: (REVISION H AND LATER PCBS)

Reference	Description	Part Number
	Power PCB Assembly MR480 Complete	043040678
	Power PCB Assembly MR700/720/730 Complete	043040637
C6, C8, C32	Cap. MKT. 100 nF 100 V	311040028
C7, C33	Cap. Poly 100 nF 250 V	316040073
C25, C27	Cap. Elec. 470 µF 25 V	999234710
C26	Cap. Elec. 2200 µF 25 V	311040695
C28, C29	Cap. Elec. 10 µF 25 V	311040663
C30, C31	Cap. Ceramic 22 nF 50 V	312040116
D13, D14, D15, D16, D17, D18	Diode 1N4002	361040163
D19, D20, D21	Diode 1N4148	361040155
F1	Fuse fast acting 1 A (20 × 5 mm)	999830001
F2	Fuse fast acting 4 A (20 × 5 mm)	999830017
F3, F4 (MR700/720/730)	Fuse fast acting 2 A (20 × 5 mm) for 230 V	999830009
F3, F4 (MR700/720/730)	Fuse fast acting 3 A (20 × 5 mm) for 115 V	999830012
F3, F4 (MR480)	Fuse fast acting 1.5 A (20 × 5 mm) for 230 V	999830008
F3, F4 (MR480)	Fuse fast acting 2 A (20 × 5 mm) for 115 V	999830009
Q6, Q10, Q12	Transistor BC547B	361040159
Q5	Transistor BC557B	361040156
Q7	IC 5 V Regulator 7805	999600003
Q8	IC 5 V negative Regulator 79L05	363040146
Q9, Q11	Triac BTA 08-600	999550011
U11, U12	IC Optocoupler MOC3021 or MOC3022	367060001
U13	IC Optocoupler CNY17-2	363040045
R9	Resistor 18E 0.25 W 5%	325040366
R44, R46, R48, R50, R54, R58, R60, R66	Resistor 10k 0.25 W 5%	325040284
R45, R55, R61	Resistor 2k7 0.25 W 5%	999012720
R47	Resistor 22k 0.25 W 5%	325040318
R49	Resistor 120E 0.25 W 5%	325046034
R51, R52	Resistor 3k3 0.25 W 5%	325040303
R53, R59	Resistor 270E 0.25 W 5%	325040294
R56	Resistor 12k 0.25 W 5%	325040289
R57	Resistor 180E 0.25 W 5%	325040309
R64	Resistor 220E 0.25 W 5%	325040296
R67	Resistor 1M 0.25 W 5%	325052305
R68	Resistor 100k 0.25 W 5%	325040139
	Fuse Clips	999840001

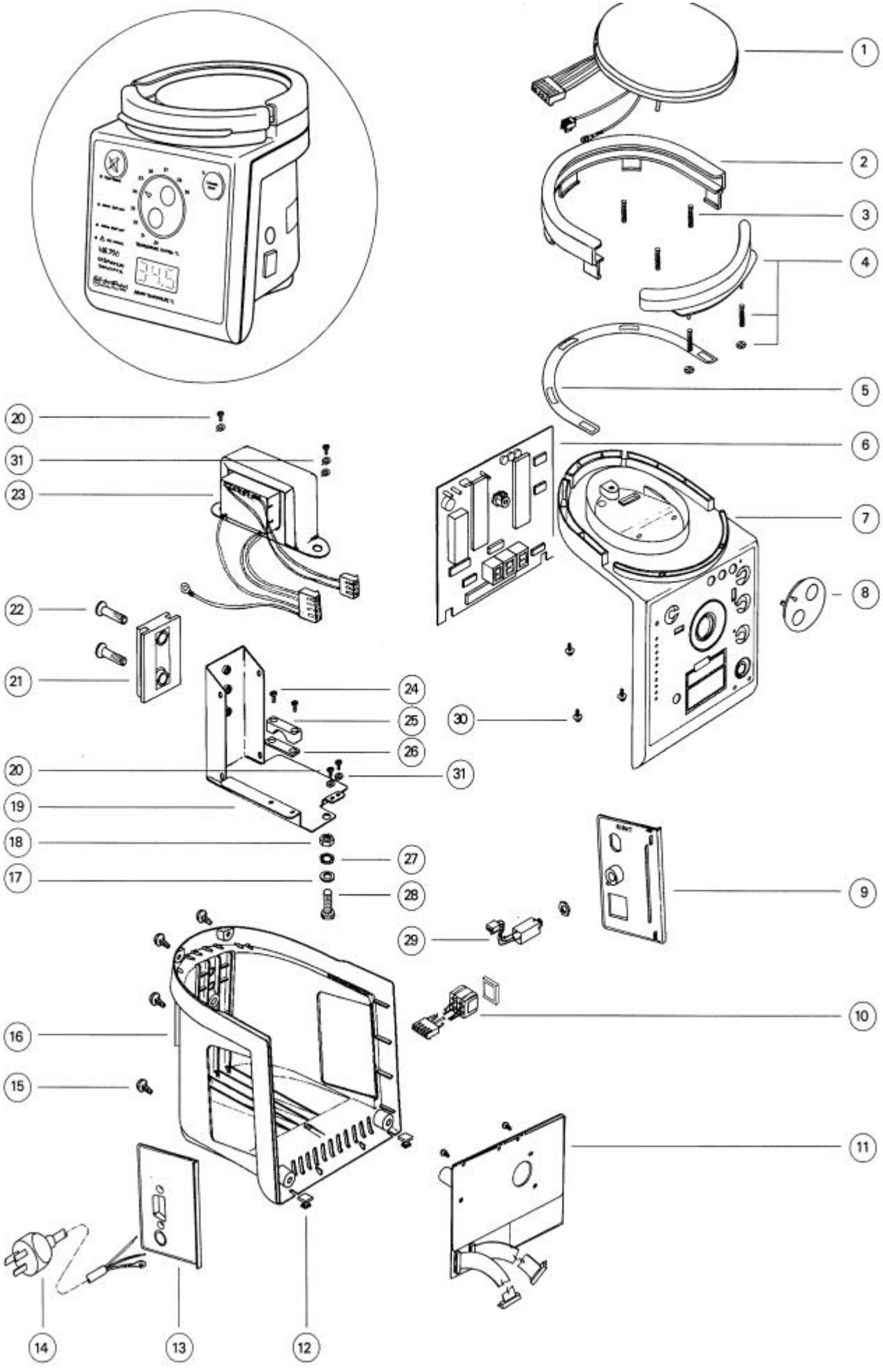
8.10 MECHANICAL PARTS LIST

The mechanical components listed below are referenced in accordance with the appropriate exploded diagrams following.

8.10.1 MR480 MECHANICAL PARTS

Reference	Description	Part Number
1	Heaterplate Assembly 150 W 100 V	043040701
	Heaterplate Assembly 150 W 115 V	043040700
	Heaterplate Assembly 150 W 230 V	043040695
2	Clamp Chamber Kit Blank (includes Gasket Ref. 5)	043040829
	Clamp Chamber Kit French (includes Gasket Ref. 5)	043040830
	Clamp Chamber Kit German (includes Gasket Ref. 5)	043040831
	Clamp Chamber Kit English (includes Gasket Ref. 5)	043040834
3	Spring Mounting	662040040
4	Guard Chamber Kit	043040709
5	Gasket Clamp	336060126
6	PCB Assembly MR480 Control No Eprom	043040679
7	Case Front Kit MR480 English	043040713
	NOTE, for other Case Front Kits - Specify Model Number eg "Case Front Kit MR480AGM"	
8	Knob Control	281150393
9	Case Door Right	693040473
10	Switch Harness Assembly	043040697
11	PCB Assembly MR480 Power Complete	043040678
12	Case Foot	693040478
13	Case Door Left	693040472
14	Mains Cord MR700 USA Hosp Grade 3.3m UL	095428157
	Mains Cord MR700 Australian Clear Plug 3.3 m	095428159
	Mains Cord MR700 No Plug 3.3 m	095428160
	Mains Cord MR700 French 230 V No Plug 3.3 m	095428203
	Mains Cord MR700 Danish Plug 230 V 2.9 m	095428204
	Mains Cord MR700 USA Hosp Grade 2 ft 90° Plug UL	095428205
	Mains Cord MR700 UK Plug 230 V Fused 3.3 m	095428214
	Mains Cord MR700 Schuko Plug 230 V 3.3 m	095428217
	Mains Cord MR700 Schuko Plug 230 V 3.3 m Earth Lug	095428226
15	Screw #8 × 1/2" Pan Phil TY25 S/S	614040120
16	Case Body kit MR480AEA English - Australasia	043041063
	Case Body kit MR480JHB English/Spanish	043041027
	NOTE: For other Case Body Kits, - Specify Model Number eg "Case Body Kit MR480AGM"	
17	Washer M6 Wavey	622040140
18	Nut M6 Nyloc ZPS	621040524
19	Bracket Transformer	641040706
20	Screw M4 × 8 Pan Phil ZP Taptite	614040117
21	Bracket Mounting 30mm × 5mm Tongue	693040491
22	Screw M6 × 25 Csk Allen S/S	614040208
23	Transformer Assembly MR480 230 V	043040551
	Transformer Assembly MR480 115 V	043040850
24	Screw M4 × 14 Pan Phil Taptite Ychr	614040223
25	Clamp Cord Small	693040476
	Clamp Cord Large	693040477
26	Spacer Hose Heater Cord	336060064
27	Washer M6 Ext Fan Disk Lock Zn/St	622041013
28	Screw M6 × 16 Allen S/S Button Head	614040230
	Lug Earth	345060096
29	Probe Socket Harness Assembly	043040698
30	Screw M3 × 5 Taptite Pan Phil Ychr	614040116
31	Washer Lock M4 Int Zn/Pl	622040130

8.10.2 EXPLODED DIAGRAMS: MR480

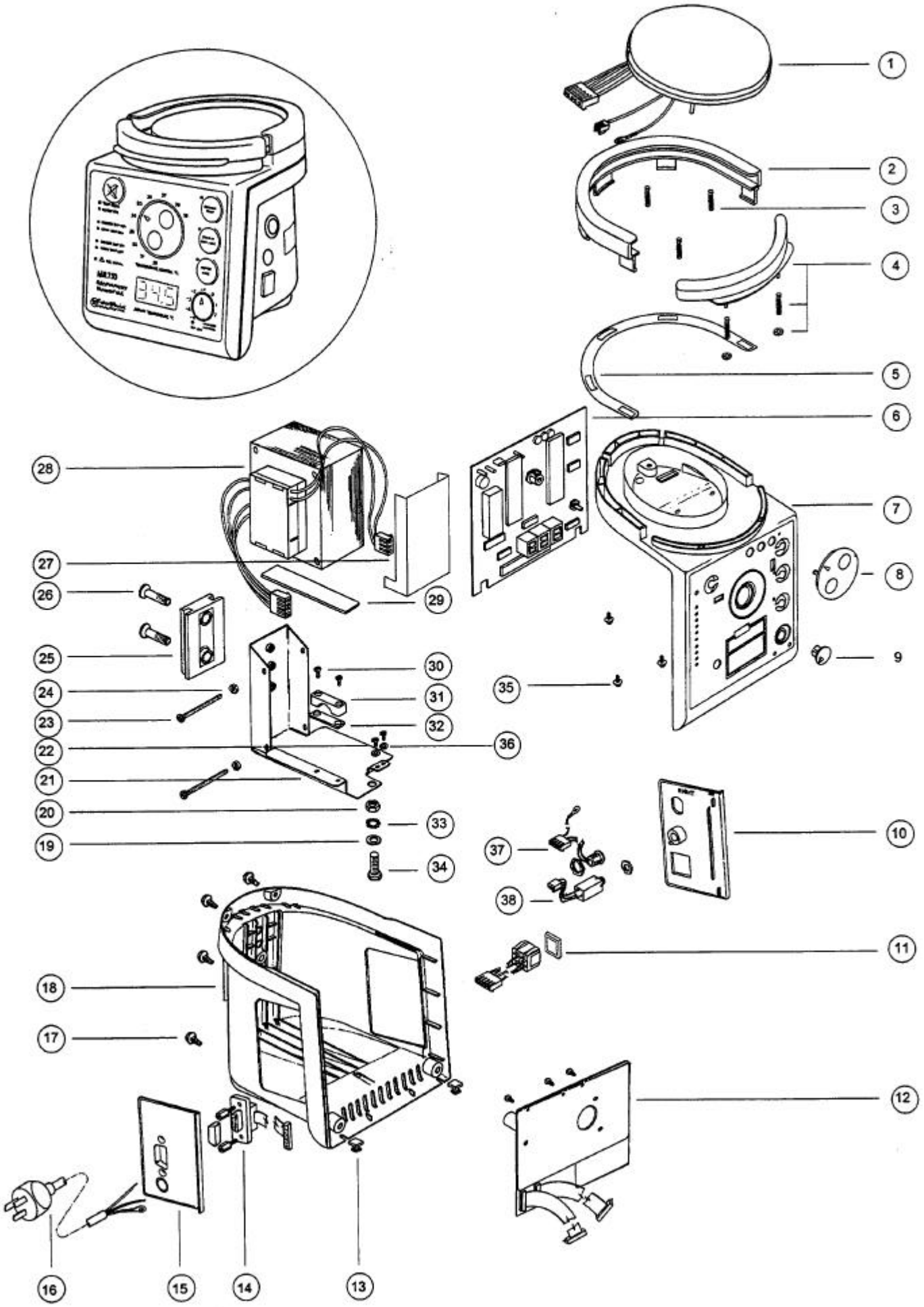


8.10.3 MR730/720/700 MECHANICAL PARTS

Reference	Description	Part Number
1	Heaterplate Assembly 150 W 100 V	043040701
	Heaterplate Assembly 150 W 115 V	043040700
	Heaterplate Assembly 150 W 127 V	043040839
	Heaterplate Assembly 150 W 230 V	043040695
	Heaterplate reflector upgrade kit (includes new front case and reflector)	043042054
2	Clamp Chamber Kit Blank (includes Gasket Ref. 5)	043040829
	Clamp Chamber Kit French (includes Gasket Ref. 5)	043040830
	Clamp Chamber Kit German (includes Gasket Ref. 5)	043040831
	Clamp Chamber Kit English (includes Gasket Ref. 5)	043040834
3	Spring Mounting	662040040
4	Guard Chamber Kit	043040709
5	Gasket Clamp	336060126
6	PCB Assembly MR700 Control No Eprom	043040633
	PCB Assembly MR720 Control No Eprom	043040677
	PCB Assembly MR730 Control No Eprom	043040675
7	Case Front Kit MR700 English	043040710
	Case Front Kit MR700 French/Dutch	043041132
	Case Front Kit MR700 German/French	043041128
	Case Front Kit MR720 English	043040711
	Case Front Kit MR720 French/Dutch	043040803
	Case Front Kit MR730 English	043040712
	Case Front Kit MR730 French/Dutch	043040804
	Case Front Kit MR730 German/French	043040774
	Case Front Kit MR730 Italian	043041243
	NOTE: For other Case Front languages Specify Model Number eg "Case Front Kit for MR720ASU"	
8	Knob Control	281150393
9	Knob Offset	693040475
	Knob Fixed Offset	693040483
10	Case Door Right	693040473
11	Switch Harness Assembly	043040697
12	PCB Assembly (MR730/720/700) Power Complete	043040637
13	Case Foot	693040478
14	Harness Assembly DB9 (RS232)	043040699
15	Case Door Left	693040472
16	Mains Cord MR700 USA Hosp Grade 3.3 m UL	095428157
	Mains Cord MR700 Australian Clear Plug 3.3 m	095428159
	Mains Cord MR700 No Plug 3.3 m	095428160
16	Mains Cord MR700 French 230 V No Plug 3.3 m	095428203
	Mains Cord MR700 Danish Plug 230 V 2.9 m	095428204
	Mains Cord MR700 UK Plug 230 V Fused 3.3 m	095428214
	Mains Cord MR700 Schuko Plug 230 V 3.3 m	095428217
	Mains Cord MR700 Japanese - Right Angle Plug 3.3m	095428308
	Mains Cord MR700 Schuko Plug 230 V 3.3 m Earth Lug	095428226
17	Screw #8 × 1/2" Pan Phil TY25 S/S	614040120
18	Case Body Kit MR700AFU French/Dutch	043041133
	Case Body Kit MR700ALU Italian/English	043041244
	Case Body Kit MR700AEA Australasia Models	043040989
	Case Body Kit MR700AGM/AGU German Models	043042058
	Case Body Kit MR700GEU English - Japanese Models	043040775
	Case Body Kit MR720AEA Australasia Models	043040990
	Case Body Kit MR720AFU French/Dutch	043040807
	Case Body Kit MR720JHB English/Spanish Baxter	043040714
	Case Body Kit MR730AFU French/Dutch	043041134
	Case Body Kit MR730AEU English/French	043040800
	Case Body Kit MR730AEA Australasia Models	043040991
	Case Body Kit MR730AND/ADU Norway/Denmark	043042055
	Case Body Kit MR730GEU English Japan	043040776
	Case Body Kit MR730AGU German/French	043040977
	Case Body Kit MR730JEB English/French Baxter	043040921

	Case Body Kit MR730JEU English/French Canadian	043041335
	Case Body Kit MR730JHB English/Spanish Baxter	043040715
	NOTE: For other Case Body types Specify Model Number eg "Case Front Kit MR720ASU"	
19	Washer M6 Wavey	622040140
20	Nut M6 Nyloc ZPS	621040524
21	Bracket Transformer	641040706
22	Screw M4 × 8 Pan Phil ZP Taptite	614040117
23	Screw M4 × 50 Pan Phil ZP	614040214
24	Nut M4 Nyloc ZPS	621040517
25	Bracket Mounting 30 mm × 5 mm Tongue	693040491
26	Screw M6 × 25 Csk Allen S/S	614040208
27	Insulator Transformer	331040158
28	Transformer Assembly (MR700 Series) 100 V	043041289
	Transformer Assembly (MR700 Series) 115 V	043041288
	Transformer Assembly (MR700 Series) 127 V	043040931
	Transformer Assembly (MR700 Series) 230 V (double insulated)	043041287
29	Tape Foam Adhesive 3 mm × 10 mm × 60 mm	254040059
30	Screw M4 × 14 Pan Phil Taptite Ychr	614040223
31	Clamp Cord Small	693040476
	Clamp Cord Large	693040477
32	Spacer Hose Heater Cord	336060064
33	Washer M6 Ext Fan Disk Lock Zn/St	622041013
34	Screw M6 × 16 Allen S/S Button Head	614040230
	Lug Earth	345060096
35	Screw M3 × 5 Taptite Pan Phil Ychr	614040116
36	Washer Lock M4 Int Zn/Pl	622040130
37	Harness J10-Hose & Socket Heater Wire Kit	043040961
38	Probe Socket Harness Assembly	043040698
38	Cap for probe socket	693041379
	Instruction swing tag English	185041088
	Instruction swing tag French	185041147
	Instruction swing tag German	185041144
	Instruction swing tag Italian	185041145
	Instruction swing tag Dutch	185041324
	Instruction swing tag Spanish	185041146
	Instruction swing tag Portugese	185041334
	Instruction swing tag Swedish	185041331
	Instruction swing tag Finnish	185041333
	Instruction swing tag Norwegian	185041332
	Instruction swing tag Japanese	185041148
	Instruction swing tag Danish	185041335

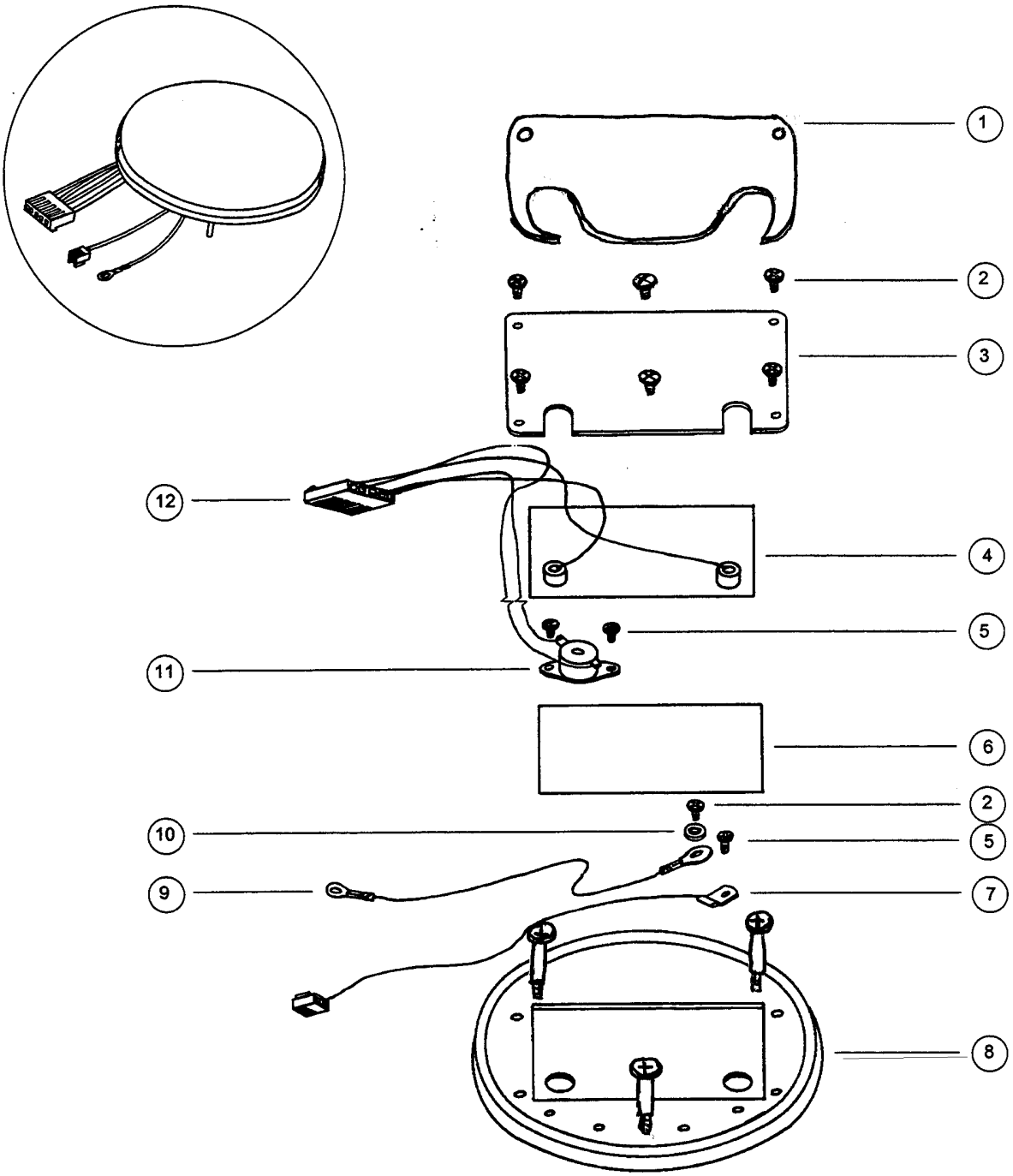
8.10.4 EXPLODED DIAGRAMS: MR730/720/700



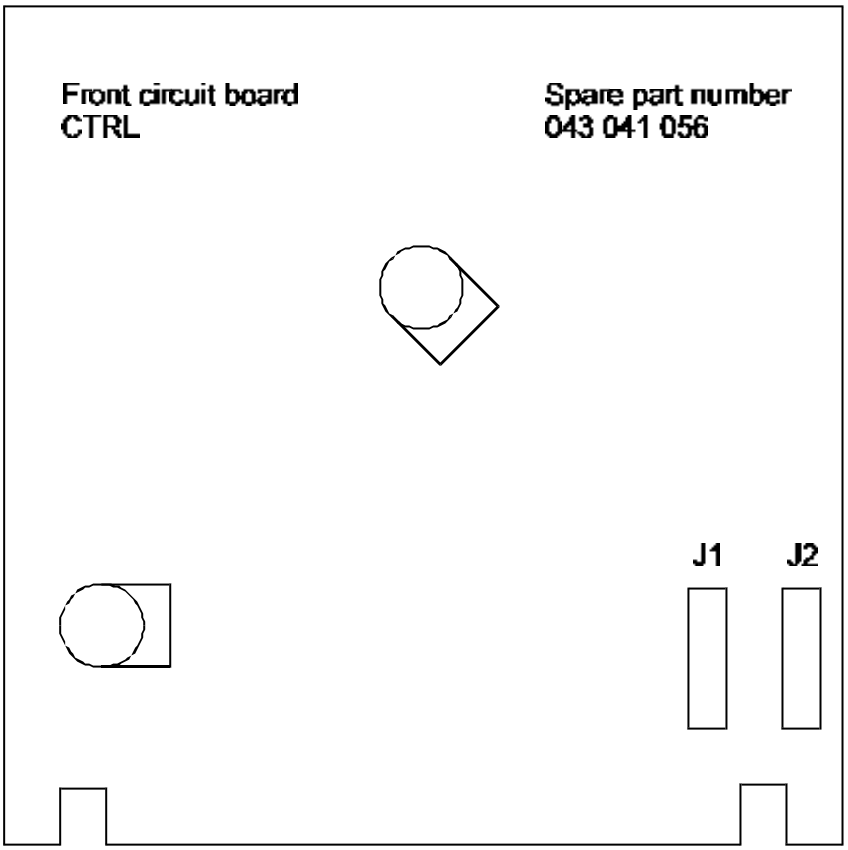
8.10.5 HEATERPLATE ASSEMBLY PARTS (MR730/720/700/480)

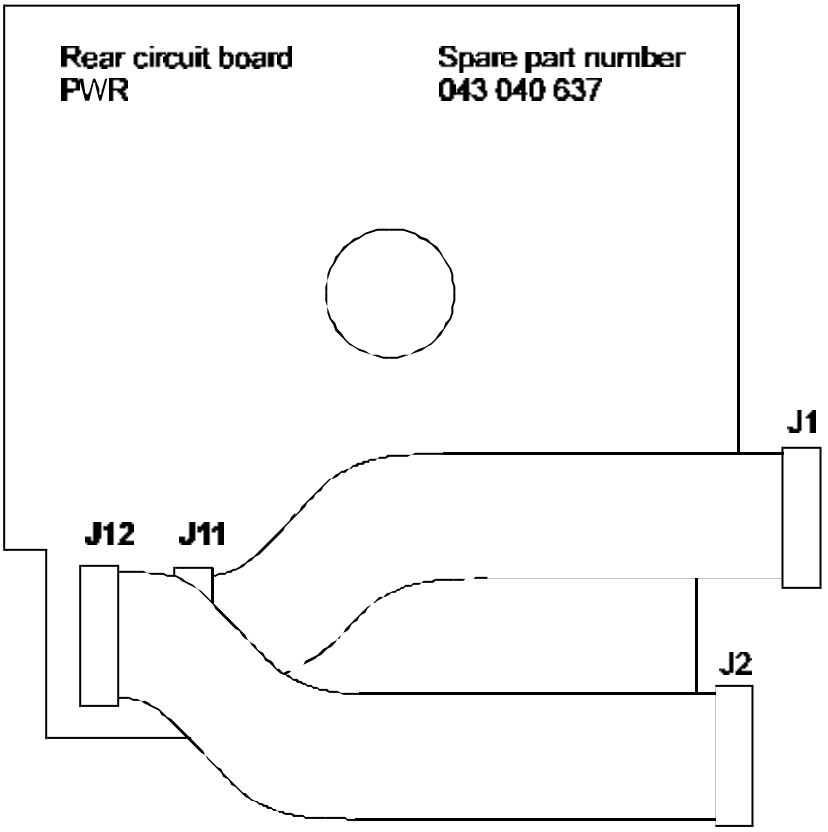
Reference	Description	Part Number
1	Reflector (added after 01/01/99)	641040829
2	Screw M4 × 8 Pan Phil Taptite	614040117
3	Cover Element Plate	641040707
4	Element Assembly 230 V 150 W	043040893
	Element Assembly 127 V 150 W	043040833
	Element Assembly 115 V 150 W	043040894
	Element Assembly 100 V 150 W	043040895
5	Screw M3 × 5 Taptite Pan Phil Ychr	614040116
6	Insulator Element	331040114
7	Thermistor and Harness Assembly	095428156
8	Plate Heater	043040875
9	Harness Heaterplate - Earth	095428154
10	Washer Lock M4 Int Zn/Pl	622040130
11	Thermostat 118 Degree Centigrade	349040052
12	Harness J7 - Heaterplate	095428279
NS	Screw in style standoffs	336060143
NS	Reflector upgrade kit (includes new front case)	043042054

8.10.6 EXPLODED DIAGRAMS:HEATERPLATE ASSEMBLY MR730/720/700/480 (INVERTED VIEW)

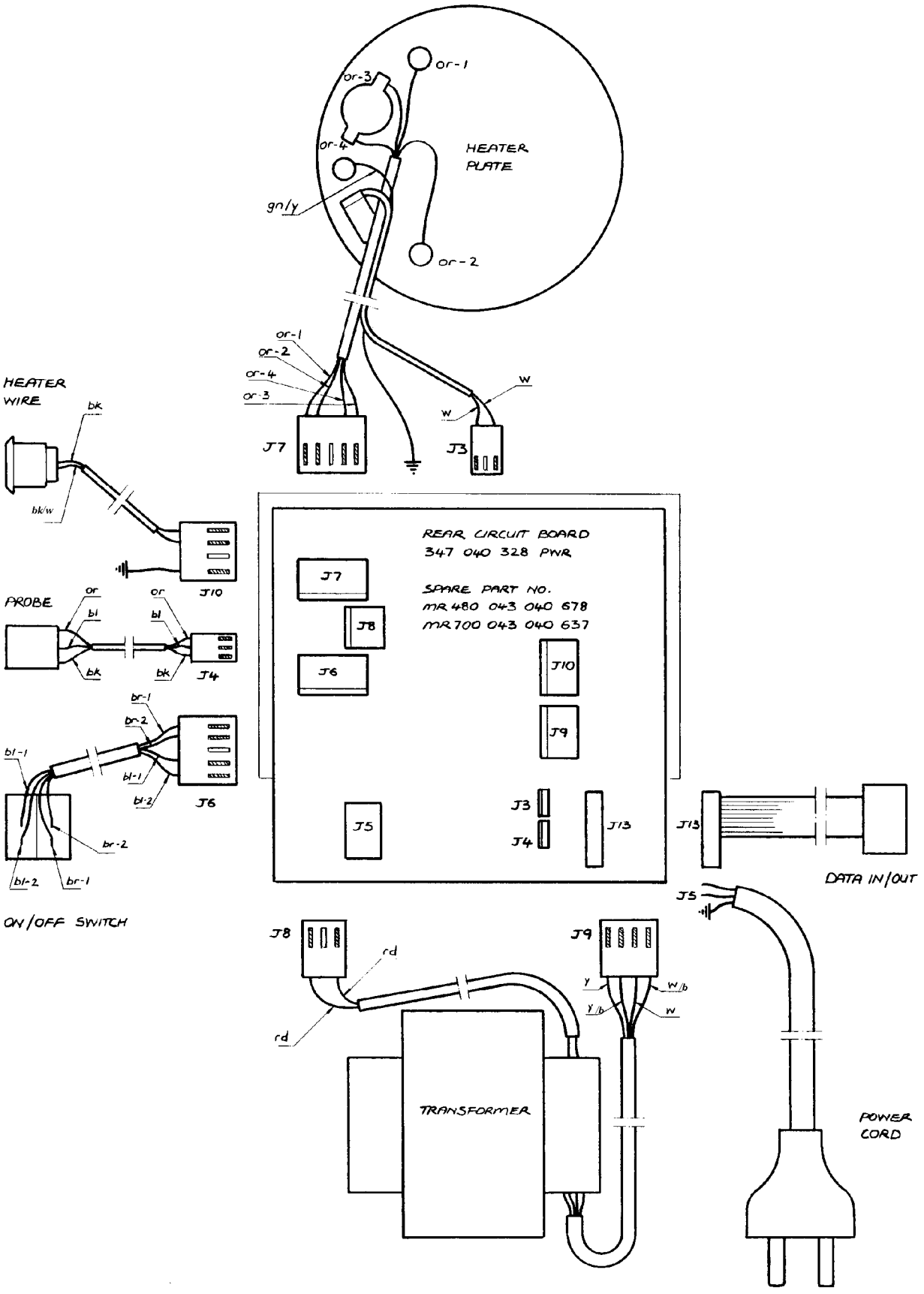


8.11 PCB IDENTIFICATION DIAGRAM





8.12 POWER PCB HARNESS CONNECTION DIAGRAM



9.0 PRODUCT CHANGE HISTORY

This change history details changes which may have significance for servicing. It does not include changes that are insignificant to users or service technicians. Refer also to change panel on circuit diagrams.

DATE	CHANGE NUMBER	FIRST SERIAL NUMBER AFFECTED	COMMENTS
29/06/92	1056	92XXAAA02786	Introduction of Version 2.0 Software. • Changes from Version 1.0 are: • Delay on chamber temperature display. • Sensitivity of control knobs increased. • Auto standby mode for MR720. (Note: this change not introduced on AF- and AG- models until serial number 93XXAAA01818, excluding AGM models).
03/08/92	1019	92XXAAA05495	Enhanced 41 °C calibration - with introduction of Rev F PCB. Note: this change not introduced on AF- and AG- models until serial number 93XXAAA01818).
22/01/93	1363	93XXAAA01818	Introduction of Version 2.0 Software on AF- and AG- models. Note: this change not introduced on AGM models.
25/01/93	1100	93XXAAA02582	C7 added, R57 changed to 390E from 1k2.
7/06/94	1992	9473JES08020 (1)	Version 3.0 software started.(All countries except Japan and German) Changes from version 2.0 are: • Standby mode times out after 30 minutes (was 20). • Low temperature alarm in warm up mode activated sooner. • Set low indicator alarm changed. • Display during A to D calibration improved.
12/10/94	2088	9473AGU17549	AGU AND AGT Models to version 3 software.
22/08/94	2079	9473AGM14257	MR730AGM to version 3 software.
15/12/94	2161	9473GES22496	MR730GES to version 3 software .
17/02/95	2313	9573GEU03084	MR730GEU to version 3 software.
3/07/95	2469	9541JHB10757	Electroless nickel plating on heaterplate started.
9/08/95	2433	9573JHB12155	Changed recommended settings on front fascia panel to 39, -2.
1/10/95	2443	9573AEA15923	Introduction of Rev H PCB on MR700/720/730. Change Molex connectors style on power PCB.
01/4/97	3212	9773XXX08041	Introduction of Revision J PCB on MR700/720/730.
23/5/97	3303	9748XXX10692	MR480: Introduce Revision J PCB. Transformer secondary wiring changed (earth wire removed). Earth wire added to PCB.
30/5/97	3308	9773XXX19731	Heaterplate standoff style changed to shoulder bolts.
01/01/98	3934	9973XXX00001	Heaterplate surface changed to Anodised
01/01/99	4371	2000-73XXX00001	Reflector added to underside of heaterplate

For software and hardware compatability see § 7.3.

9.1 MODEL NUMBER EXPLANATION

eg MR730AEU (model type MR730, with specific variations as below).

The table below lists variations in models that are for general sale, there are some models which are sold to specific customers that are not shown here.

First Letter	Voltage	Second Letter	Third letter	Front Panel Language	Side Panels Language
A	230 ± 25 V	D		English	English/German
P	127 ± 10 V	E		English	English/French
J	115 V	F		French/Dutch	French/Dutch
G	100 ± 10 V	G		German/French	English/German
		H		English	English/Spanish
		J		Japanese	English/Japanese
		L		Italian	English/Italian
		S		Spanish/Portugese	Spanish/Portugese
		W	M	Swedish	Swedish/Finnish
		D	N	Danish	Danish/Norwegian
		D	U	Danish	Danish/English
		N	U	Swedish/Finnish/Norwegian	Swedish/Finnish/Norwegian
		P	U	Polish	Polish/English
		R	U	Russian	Russian/English

9.2 SERIAL NUMBER EXPLANATION

92	XX	AAA	XXXXX
YEAR	MODEL	CODE	SERIAL NUMBER
	41 MR410	Three letter code is as per above specification.	
	48 MR480		
	70 MR700		
	72 MR720		
	73 MR730		

APPENDIX A

A1 CALIBRATION MODE

Entry to the calibration mode is made by holding down the 'Chamber Temp' button and turning on the Mains Power switch.

After a two second delay the display should show '-1-'.

On releasing the 'Chamber Temp' button the display will show the humidifier model number (730/720/700 or 480).

The 'Chamber Temp' button is now used to step between functions as shown below.

1 Model number display.
2 Software version display.
3 Traceability number.
4 41.0 °C comparator calibrate. VR4.
5 ADC zero calibrate. VR5.

On pushing the 'Chamber Temp' button the display will show the present function number then after a one second delay step to the next higher function number, where if the 'Chamber Temp' button is then released then that function is entered

The calibration mode will time out (to normal operating mode) 5 minutes after the last 'Chamber Temp' button push. The normal exit mode is to turn the humidifier mains power switch off then on again.

For details on 41.0 °C and ADC zero calibration procedures refer § 5.3.

A2 ENGINEERING MENU

To enter the engineering menu push the Mute and 'Chamber Temp' buttons simultaneously and hold for at least 1.5 seconds. At this time the display will show SET (for set temperature display) as a pointer to that function and on release of the 'Chamber Temp' button the display will show the set Temperature Control temperature setting to one decimal place. To maintain this display, the Mute button should be kept depressed. If the Mute is released, the display will revert to normal operation in about 6 seconds.

The display can be stepped through the engineering menu in two ways.

- If the Mute is held down constantly the functions can be selected sequentially by pressing the 'Chamber Temp' until the display changes to the next function pointer, where if the 'Chamber Temp' button is then released the display will show that function.
- Releasing the mute button the humidifier will automatically step through the menu until either the mute button is pressed whereupon the display will show that function or if 6 seconds has elapsed and the humidifier will display 'End'.

If 'End' appears on the display and the Mute button is momentarily pushed the time out will be inhibited and the stepping through the function pointers continued.

A2.1 ENGINEERING DISPLAY FUNCTIONS: HEATER WIRE MODE

SET Set temperature display (°C).
OFF Offset temperature display (Chamber Control) (°C).
Edc Heater wire duty cycle (%).
Cdc Heaterplate duty cycle (%).
hP Heaterplate temperature (°C).
L Programming link status.(L1, L2, ... L6).
CP Compare probes (Probe test).
Ei Heater wire integral.
Ti Heaterplate integral.

A2.2 ENGINEERING FUNCTIONS: NON HEATER WIRE MODE

SET	Set temperature display (°C)
dc	Heaterplate duty cycle (%)
hP	Heaterplate temperature (°C)
L	Programming link status
CP	Compare probes (Probe test)
i	Heaterplate Integral

A2.3 INTEGRAL DISPLAY

The integral is an error offset signal which constantly accrues to compensate for the temperature difference between the set control and probe. It is displayed in the 'Ei' and 'Ti' engineering functions in hexadecimal notation, ie. the count progresses from 0 to 9 then continues through A b c d E F before cycling back to 0. A negative integral is indicated by the three 'decimal points' in the display being lit. The magnitude of the integral is ± EFF (± 3839 in decimal notation).

A3 PROGRAMMING CONTROL OPTIONS

The following options can be enabled by joining the pads on the control PCB as shown.

x = don't care.
1 = link.
0 = no link.

L1	L2	L3	
x	x	0	ISO draft standard audio alarm.
x	x	1	Gliding tone audio alarm.
1	0	x	50 °C maximum temperature Heaterplate.
1	1	x	80 °C maximum temperature Heaterplate.
0	1	x	90 °C maximum temperature Heaterplate.
0	0	x	110 °C maximum temperature Heaterplate.

The state of the above links can be displayed in the engineering menu ('L').

The factory default settings are for the ISO alarm and 110 °C heaterplate, except MR720 which has an 80 °C heaterplate.

A4 ERROR CODES

During operation, if the microprocessor U3 does not receive an expected interrupt within a given time window an error condition will be flagged. In particular the RST6.5 interrupt which marks the termination of the integration ramp from U10-E and also controls the counter in U4 will, in the event of the count exceeding certain limits, generate an error message.

Some of the error indications which can be displayed on the MR700 Series digital display are listed below, with an explanation of the possible cause.

Error Messages

Ec	Checksum error (possible failure of U1 EPROM).
En	Memory test error (possible failure of U4 RAM).
EXx	Where X = 0 through 7, indicating multiplexer stage where error occurred. Where x = o or u, indicating ADC overflow error or underflow error, at the indicated multiplexer stage. (ADC counts outside the expected range will generate either an under or overflow error).
b-1	The Mute button is on at turn on or has been on for > 5 minutes.
b-2	The Standby button is on (see b-1 above).
F-2	The Heater Wire fuse, F2 is open circuited.
---	Temperature sensor probe fault (see Sect.3.1).

The following errors may occur during the software-driven shorted probe cable test. If the errors do not persist they do not necessarily indicate a faulty probe assembly. It is because of conflicting results during the test that a definite conclusion cannot immediately be made.

Errors EP2 to EP4 can be caused for example by abnormal high differential temperatures on the two thermistors or by rapidly changing input temperatures.

EP1 Hardware fault; Q13 short not effective.

EP2 Low probe temperature (~0 °C).

EP3 High probe temperature (~70 °C).

EP4 Partial short between the active probe cable conductors.

A5 MR700 SERIES HUMIDIFIER SERIAL DATA INTERFACE

A5.1 SERIAL DATA FORMAT

1 byte	: (semi colon) Marks beginning of data record.
4 bytes ASCII	Temperature Control setting.
4 bytes ASCII	Airway temperature.
4 bytes ASCII	Chamber temperature.
4 bytes ASCII	Heaterplate temperature.
4 bytes ASCII	Heater wire duty cycle.
4 bytes ASCII	Heaterplate duty cycle.
4 bytes ASCII	Chamber Control setting .
4 bytes *	Status information. (1*ASCII 3*binary bytes).
2 bytes	CR, LF (Marks end of data record).

Between each of the above lines there is approximately a 50 ms pause before the next line is transmitted. The complete data record is repeated every 500 to 600 ms (500 ms on a 60 Hz supply, 600 ms with 50 Hz).

Data format is RS232 levels, no handshaking, 9600 baud, 8 bits, no parity, with one stop bit.

Between the semi colon and the line feed there are eight, 4-byte packets of information as shown above.

In each case the first byte of the packet contains an identification letter from ‘a’ through ‘h’ in ASCII.

The format of the 3 bytes following the ASCII I.D. is as shown below.

I.D. a - SET temperature.

I.D. b - Airway temperature.

I.D. c - Chamber temperature.

Range 5.0 to 80.0 °C, decimal point is assumed between 1st and 2nd digits.

I.D. d - Heaterplate temperature.

Range 14.0 to 99.9 °C decimal point assumed, 100 to 135°C no decimal point.

I.D. e - Heater Wire duty cycle.

I.D. f - Heaterplate duty cycle.

Range 0 to 100 %.

I.D. g - Chamber Control Setting.

Range -5.0 to +2.0 decimal point assumed. Plus or minus sign in leading ASCII byte.

I.D. h - Status information.

A5.2 STATUS INFORMATION

The ASCII I.D. is followed by three binary bytes giving alarms and error information, see list below:

The data record as received should start with an ':' and end with an 'LF'. Under abnormal operating conditions however (when there are 'E' messages in the display) some or all of the above packets 'a' to 'g' can be missing. The status information packet 'h' will always be present (as long as the micro is running) and will show the error condition.

When there are error messages in the display, bit 6 of the last status byte will be set high indicating a fatal error condition.

First Byte

Bit0 Probe disconnect LED

Bit1 Heater Wire disconnect LED

Bit2 Airway Temp Low LED

Bit3 Airway Temp High LED

Bit4 Chamber Temp Low LED

Bit5 Chamber Temp High LED

Bit6 Chamber Temp Button LED

Bit7 Always set high

Second Byte

Bit0 Standby button LED

Bit1 Heater Wire operation LED

Bit2 Remote Shut Down request acknowledge

Bit3 Set Low LED

Bit4 Audio alarm muted

Bit5 External request acknowledge Heater Wire operation

Bit6 External request acknowledge No Heater Wire operation

Bit7 Always set high

Third Byte

Bit0 Heaterplate ON

Bit1 Heater Wire ON

Bit2 Always low

Bit3 Always low

Bit4 See table

Bit5 See table

Bit6 Fatal error

Bit7 Always set high

Bit4	Bit5	Model
0	0	MR480
1	0	MR700
0	1	MR720
1	1	MR730

A5.3 REMOTE STANDBY

A constant high input (pin 2 DB9 connector >1.5 V) shuts down the humidifier. Low or open circuit input enables the humidifier. An RSD request signal puts the humidifier into the standby mode; i.e. No low alarms active, controlled 40.0 °C heaterplate and 15% Heater Wire duty cycle. On removal of an RSD request the humidifier enters the warm up mode. On the MR730/720 models the standby LED is also turned on (not flashing).

A5.4 SERIAL DATA INTERFACE CONNECTOR

A DB9 connector on the side of the humidifier provides the interface connections.

pin 2 Remote shut down input (Serial in).

pin 3 Serial Data output.

pin 5 Humidifier Earth.

pin 7 +5 V (30 mA max)

APPENDIX B

B1 MAINTENANCE SCHEDULE

The MR700 series humidifiers operating software continually monitors the performance characteristics of the humidifier reporting any errors and in the event of a fatal error terminates operation in a fail safe mode. For this reason preventative maintenance of the humidifier need only be performed at extended intervals.

The following list of routine checks are recommended to be performed at the intervals stated.

For each maintenance check fill out a checklist, as given in Appendix B2.

B1.1 MONTHLY

Perform the following:

1 Check temperature probe for damage to sensor tips, abrasion of the cable or tarnishing of electrical contacts. Clean with alcohol on a swab or replace as necessary.

2 Remove and check the reusable hose heater wire (if fitted) for kinks and abrasions. Replace if necessary.

3 Check heater wire connector for damage to cable and both end plugs. Check for correct coupling of the plugs with their respective sockets on the heater base and heater wire assembly.

4 Check humidifier power cable for damage and replace as necessary.

5 Plug probe and heater wire (if fitted) into heater base and switch on. Observe correct operation of power up procedure. Check for no immediate alarms and correct display of ambient temperature. Continue to run for at least 30 seconds by which time all the relevant internal tests will have been completed. Switch off.

B1.2 THREE MONTHLY

Perform a temperature probe test as outlined in § 6.4.

B1.3 ANNUALLY

Execute a performance check appropriate to the humidifier model as detailed in § 6.0.

Carry out Electrical Safety checks as per Appendix B2.

B1.4 ANNUALLY OR IN ACCORDANCE WITH RELEVANT COUNTRY REGULATIONS

Carry out Electrical Safety checks, see Appendix B2.

B2 MAINTENANCE SCHEDULE CHECKLIST

(PHOTOCOPY AND FILE IN MAINTENANCE RECORDS)

Type of service check: ❑ **monthly** ❑ **3 monthly** ❑ **6 monthly** ❑ **yearly**

Humidifier Serial Number:_____ Date: _____

	Step	Method	Pass	Fail
Monthly	Check Temperature Probe	Refer Appendix B1.1	❑	❑
	Check Reusable Heater Wire	Refer Appendix B1.1	❑	❑
	Check Heater Wire Connections	Refer Appendix B1.1	❑	❑
	Check Power Cable	Refer Appendix B1.1	❑	❑
	Perform Self-Test	Refer Appendix B1.1	❑	❑
Three Monthly	Perform Temperature Probe Test and Check Temperature Probe	see § 4.3 and Appendix B	❑	❑
Annually	Performance Check	see § 6	❑	❑

Electrical Safety Checks - as required

	Method	Pass	Fail
Earth resistance test	Measure the resistance from the earth pin on the mains plug to:		
	i The heaterplate.(0.2 Ω maximum) (To get a good contact on the anodised heaterplate, clip under the front edge of it.)	❑	❑
	ii The earth stud on the base of the humidifier(0.2 Ω maximum).	❑	❑
Insulation resistance test	Use a 500V DC tester to measure the resistance from the phase pin on the mains plug to:		
	i The heaterplate (10 MΩ minimum).	❑	❑
	ii The earth stud on the base of the humidifier (10 MΩ minimum).	❑	❑
Earth Leakage test	Has to be measured using an electrical safety tester as per IEC601. Measure earth leakage with the earth probe of the tester on the heaterplate. Earth leakage current is measured at normal operating voltage and frequency of supply. Should be 0.5 mA maximum in no fault condition.	❑	❑

Signature:_____

APPENDIX C

C1 TROUBLESHOOTING GUIDE FOR THE MR700 SERIES RESPIRATORY HUMIDIFIERS

This is a guide to possible corrective action in the case of an humidifier alarm condition or malfunction. It is primarily written for humidifiers using heated wire mode. So parts of this guide would not be applicable for the MR480 and MR730 and MR720 in the heater wire off mode.

Unless the cause and immediate effects of an alarm condition are understood and assessed to be of no hazard to the patient, the humidifier should be immediately switched off and removed from the patient circuit.

C1.1 LOW TEMPERATURE

Condition detected	*Possible cause*	☞ *Action to take*
Temperature less than desired, no alarm.	Humidifier warming up.	Wait for a few minutes.
	Standby mode switched on.	Push mode button for 1 second to disable standby. Wait 20 minutes (30 minutes for v3.0 software).
	Temperature probe not in position.	Check position of temperature probe in the circuit.
Airway temperature low alarm activated.	Gas flow stopped or interrupted.	Enter standby mode or turn humidifier off until gas flow resumed. (Gas flow must be resumed before coming out of standby mode).
	Set temperature increased by more than 2 °C.	Wait for temperature to rise.
	Temperature probe not in probe housing.	Fit temperature probe.
	Gas flow rate too low.	Increase gas flow to more than 2 litres per minute.
	Too much distance between end of heater wire and temperature probe.	Use longer heater wire or shorten inspiratory hose so that distance is between 25 (1") and 100 mm (4"), ideally 30 mm.
Chamber temperature low alarm activated.	Poor thermal contact between base of chamber and heaterplate.	Check that chamber base and heaterplate are clean, smooth and flat. If necessary clean or replace. Humidification chambers which are not manufactured by Fisher & Paykel may not be suitable.
	Temperature probe not inserted at chamber outlet.	Fit temperature probe correctly.
	Heater element needs replacement.	Send for repair.
	Gas flow rate too high for chamber	Use correct chamber. Refer to the operating instructions for the type of chamber used.

C.1.2 HIGH TEMPERATURE

Condition detected	*Possible cause*	☞ *Action to take*
Airway temperature high alarm activated.	Sudden spurious increase in gas flow.	Wait for temperature to fall below threshold.
	Heater wire too close to temperature probe.	Use shorter heater wire or lengthen inspiratory hose so that distance is between 25 (1”) and 100 mm (4”), ideally 30 mm.
	Possibly faulty EOH sensor on temperature probe (low resistance).	Check probe, see § 6.4.
Chamber temperature high alarm activated.	No water in chamber.	Refill humidification chamber.
	Possibly faulty TOP sensor on temperature probe (low resistance).	Check probe, see § 6.4.

C.1.3 TEMPERATURE FLUCTUATING

Condition detected	*Possible cause*	☞*Action to take*
High and low temperature alarms.	Ventilation rate too low or too erratic for proper humidifier temperature control.	Ventilation rates below about 6 bpm or of a highly erratic nature may affect the stability of the temperature control.
	Humidifier temperature control influenced by external heating or cooling such as air conditioner.	Shield breathing circuit from external influence.
	Temperature probes incorrectly positioned.	Check temperature probe position in the circuit.
	Possibly faulty temperature probe (Could be intermittent short or open circuit).	Check probe, see Section 6.4. (Wriggle probe to pick up intermittent faults).

C.1.4 EXCESSIVE WATER IN CIRCUIT

Condition detected	*Possible cause*	☞*Action to take*
Excessive water in inspiratory circuit due to rainout.	If in non-heated wire mode, water trap not at the lowest point of the circuit.	Reposition water trap.
	If in heated wire mode, heater wire too close to temperature probe.	Increase distance from heater wire to temperature probe so that the distance is between 25 (1”) and 100mm (4”), ideally 30mm.
	Inspiratory circuit being cooled by air conditioner.	Shield circuit from air conditioner or use heater wire circuits.
	Chamber control set too high	Reduce setting.
	Maximum permissible peak flow rate of humidification chamber has been exceeded.	Use correct chamber. Refer to the operating instructions for the type of chamber used.
	Humidifier chamber tilted.	Ensure chamber is level.
	Possibly faulty temperature probe (low resistance).	Check probe, see § 6.4
	Inspiratory heater wire not connected in a parallel wired dual circuit.	Connect inspiratory heater wire.

Excessive water in expiratory circuit due to rainout.	Condensation due to cooling in Expiratory line.	Use dual heated circuit.
Water ejected from humidification chamber into circuit.	Humidification chamber filled beyond maximum water level line.	Rduce water level
	Maximum permissible peak flow rate of humidification chamber has been exceeded.	Ue correct chamber. Refer to the operating instructions for the type of chamber used.
	Humidifier chamber tilted.	Chamber should be level.

C1.5 LOW HUMIDITY

Condition detected	*Possible cause*	☞*Action to take*
Low humidity.	Chamber control set to low.	Increase setting.
	No water in humidification chamber.	Fill chamber.
	Chamber temperature low.	Check heaterplate temperature setting on diaplay when humidifier is switched on, Chamber base and heaterplate are smooth and flat and in good contact. (Chambers not made by Fisher & Paykel may not be suitable).
	Gas flow rate too high for chamber.	Check maximum flow rate in to chamber operating instructions.

C1.6 ALARMS

Condition detected	*Possible cause*	☞*Action to take*
Temperature probe alarm (‘---’ appears on display).	Temperature probe unplugged.	Check connetion.
	Temperature probe plug dirty.	Clean plug.
	Temperature probe faulty	Replace probe.
Heater wire alarm while temperature still displayed.	Heater wire unplugged.	Check connection.
	Heater wire broken.	Replace heater wire.
	Heater wire switch turned off but heater wire connected.	Turn heater wire on.
	Heater wire switch turned on but heater wire not connected.	Turn heater wire off.
Heater wire alarm while ‘F2’ displayed.	Internal fuse blown.	Send for repair.
	41 °C Overheat calibration outside limits.	Check calibration of the 41 °C comparator.

C1.7 TEMPERATURE DISPLAY

Condition detected	*Possible cause*	☞*Action to take*
No temperature display, no alarm lights.	Humidifier voltage rating incorrect.	Select correct voltage rated unit.
	Heaterplate overheat protector operated.	Reset overheat protector.
	Transformer over heat protector operated.	Replace transformer.
No temperature display, 'see manual' indicator light on.	Control PCB fault.	Check control PCB for water damage.or contamination.
Error code.	Humdifier failed self test.	Check control PCB for water damage or contamination. Check thermistor conection to control PCB. If new PCB fitted, check correct polarity of transformer secondary harness.

C1.8 BREATHING CIRCUIT LEAK

Condition detected	*Possible cause*	☞*Action to take*
Breathing circuit leak.	Faulty circuit connections.	Check all circuit connections.
	No water bag.	Connect water bag
	Temperature probes incorrectly fitted.	Check connections.
	Chamber filler stopper missing.	Put stopper in place.

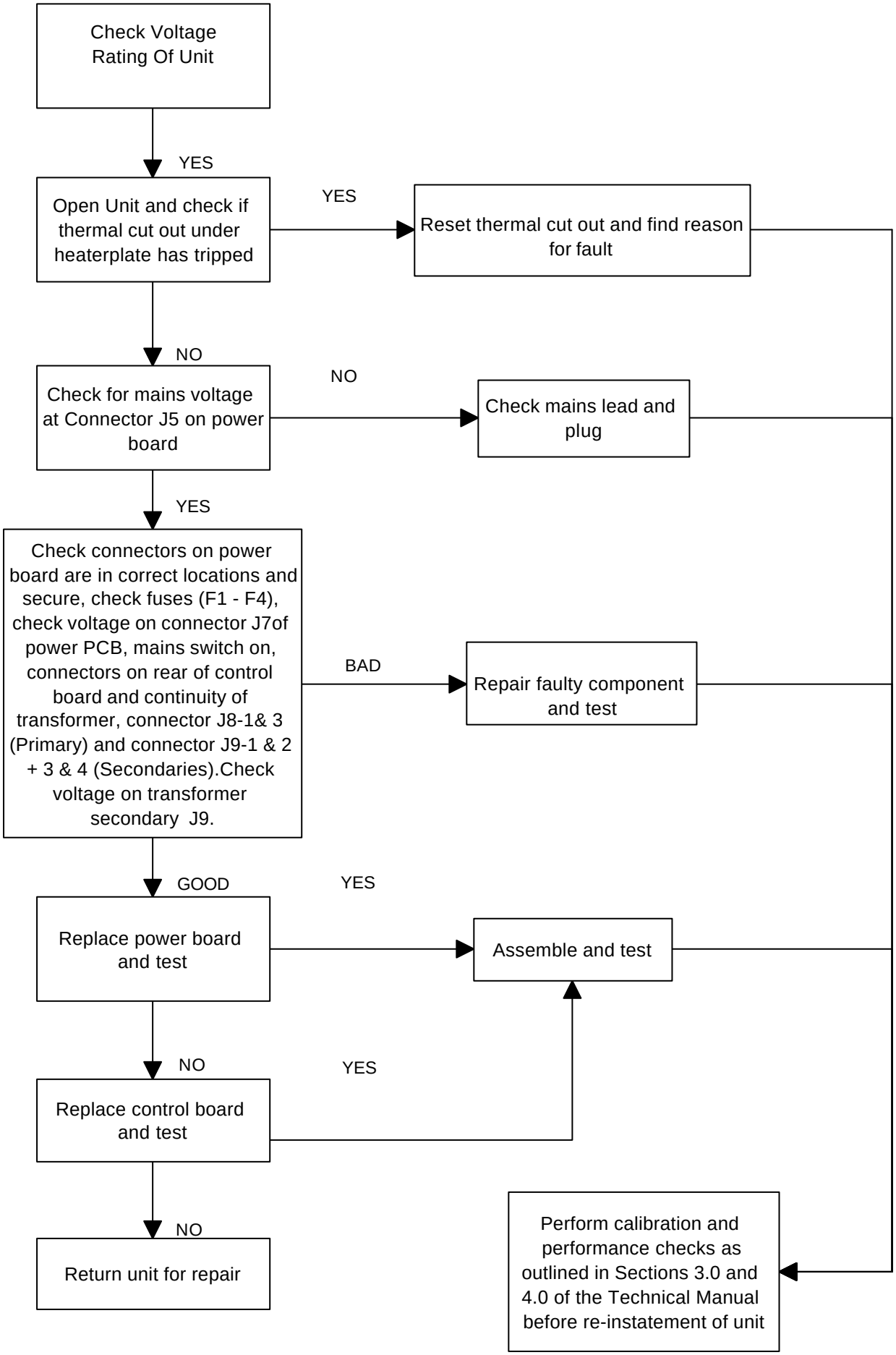
C1.9 EXTERNAL WATER LEAK

Condition detected	*Possible cause*	☞*Action to take*
Water leak with reusable chamber.	Chamber O-ring faulty.	O-ring should be clean and properly fitted. Replace if damaged.
Water leak with disposable chamber.	Chamber used beyond lifespan.	Replace with new chamber.

C1.10 LED ON

Condition detected	*Possible cause*	☞*Action to take*
An alarm LED is flashing.	No audible sound - mute switch has been pressed.	Wait three minutes.
Standby LED is flashing.	Humidifier is in standby mode.	Puch button for 1 second to disable. Wait 20 minutes (30 minutes for v3.0 software).
'Set Low' LED is on.	Chamber control or airway temperature control setting too low.	Re-adjust. Refer to humidifier operating manual.

C2 MR700 SERIES FAULT FLOW CHART FOR NO GO CONDITION


Check Voltage Rating Of Unit
YES
Open Unit and check if thermal cut out under heaterplate has tripped
YES
Reset thermal cut out and find reason for fault
NO
Check for mains voltage at Connector J5 on power board
NO
Check mains lead and plug
YES
Check connectors on power board are in correct locations and secure, check fuses (F1 - F4), check voltage on connector J7of power PCB, mains switch on, connectors on rear of control board and continuity of transformer, connector J8-1& 3 (Primary) and connector J9-1 & 2 + 3 & 4 (Secondaries).Check voltage on transformer secondary J9.
BAD
Repair faulty component and test
GOOD
YES
Replace power board and test
Assemble and test
NO
YES
Replace control board and test
NO
Return unit for repair
Perform calibration and performance checks as outlined in Sections 3.0 and 4.0 of the Technical Manual before re-instatement of unit

APPENDIX D

D1 CLEANING OF HUMIDIFIER HEATER BASES

These are the recommended cleaners for use with Fisher and Paykel heaterbases as of the time of revision of this technical manual. The disinfectants in the list below have been tested to ensure no damage to the outer plastic or metal components of the humidifier. If you wish to use a chemical other than these, please contact your local Fisher and Paykel Healthcare supplier.

Cleaning instructions

1. Disconnect the humidifier from any electrical outlet.

2. Clean the humidifier with one of the following recommended disinfectants using a damp cloth:
   Isopropyl Alcohol
   Dy-Gest I™
   2% w/v Glutaraldehyde (Cidex™)
   Sporicidin™
   Normal dishwashing detergent.
   Follow the manufacturers instructions carefully. Use the correct dilution of the disinfectant.

   DO NOT immerse the humidifier in any liquid.

3. Wipe the humidifier clear of any cleaning residues before use.

D2 CLEANING OF AIRWAY TEMPERATURE PROBES

(900MR560, 900MR561, 900MR563, 900MR565, 900MR568, 900MR569 & 900MR571)

Several chemical disinfectants have been tested with the temperature probe types listed above. The chemicals listed below have been found to not affect the integrity or performance of these temperature probes: If you wish to use a chemical or sterilization procedure other than these, please contact your local Fisher and Paykel Healthcare supplier.

Cleaning instructions

1. Physically clean the airway temperature probes, removing all visible contaminants.

2. Disinfect the airway temperature probes with one of the following solutions:

Isopropyl alcohol	Medizyme™	Sporicidin™
Control 3™	Pyroneg™	
2% w/v Glutaraldehyde(Cidex™)	Solution 2™	

   OR use one of the following sterilization procedures:
   Ethylene oxide sterilization at 55°C (131°F), 80kPa, or
   Hydrogen peroxide gas plasma (Sterrad) sterilization at 10-40°C (50-104°F).
   DO NOT immerse gold-plated electrical connector plug in disinfectant. DO NOT autoclave. **DO NOT** use dishwater detergents or solvents.

3. Wipe the airway temperature probes clear of any cleaning residues before use. Store in a clean manner.

Cidex™ is a registered trademark of Johnson & Johnson Medical Pty. Ltd. North Ryde, NSW, Australia.
Dy-Gest I™ is a registered trademark of EcoLab Ltd. Hamilton, New Zealand.
Sporicidin™ is a registered trademark of Sporicidin International Ltd, Rockville, MD 20852, USA.

APPENDIX E

E1 ADDITIONAL DYNAMIC PERFORMANCE CHECK OF HUMIDIFIERS

This procedure is optional and may be used to check the dynamic operation of MR730/720/700 and MR480 humidifiers. This performance check can be performed if there is any doubt about the operation of the humidifier, such as after any servicing involving the printed circuit boards.

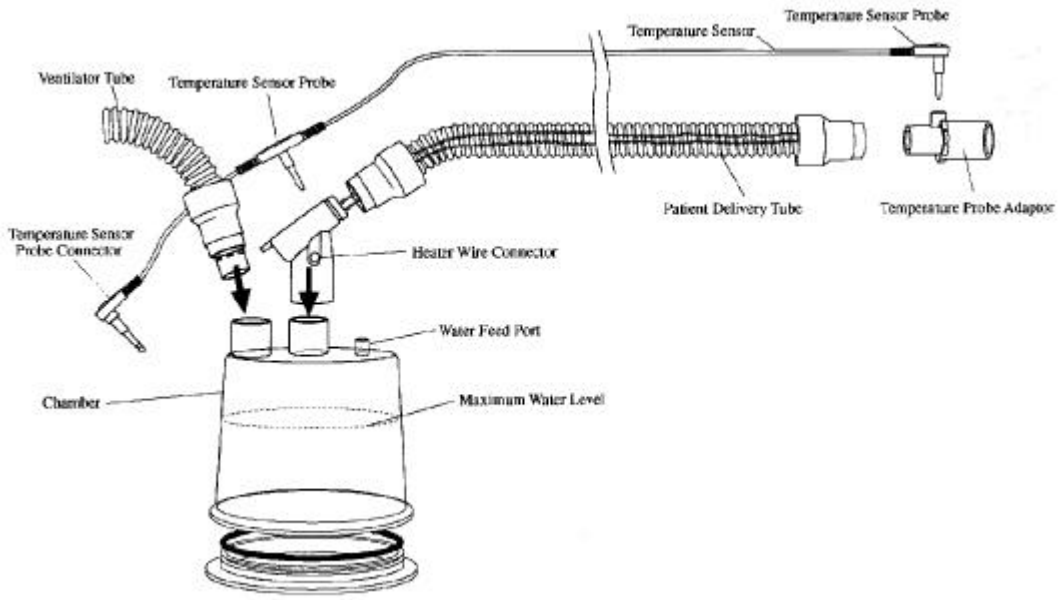
For normal routine maintenance checks only the tests detailed in Section 6 are required.

For the Dynamic Tests, the humidifier is controlled from an airway temperature probe to achieve a set temperature.The purpose of this test is to show that the humidifier control systems are working to maintain delivered air temperature to the set temperature.

E2 PERFORMANCE CHECK MR730/720/700

E2.1 EQUIPMENT SETUP

Set up a heated breathing circuit, see typical setup below:



Setup Notes:

- Patient delivery tubing can be single use or reusable.
- A gas supply of 2 – 10 l/minute to the chamber is recommended, if no gas supply is used, then the breathing tube must be 22mm diameter to allow adequate airflow.
- Heater wire assembly can be single use or reusable, dual heated or single limb. Total power less than 60 Watts. If a single use circuit is used then an air flow of at least 2 litres/min is necessary.
- Use a dual airway temperature sensor, such as 900MR560.
- Use any Fisher and Paykel humidification chamber, filled with cold water to maximum level.

E.2.2 SETUP

1 Slide the full humidification chamber on to the heaterbase.

2 Insert the middle sensor of the temperature probe into the heater wire module, and the end sensor of the temperature probe into the connector at the end of the delivery tube, plug the temperature probe plug in to the humidifier .

3 Connect the Heater Wire cable to the humidifier.

4 If a gas supply is used, set to 5- 10 l/minute, if no gas supply used, the breathing tube should be supported from the patient end so that it drops vertically over its entire length to the top of the chamber.

E.2.3 DYNAMIC TEST SEQUENCE (MR730/720/700)

1 Turn the humidifier on, ensure the heater wire LED is on for a MR720 or MR730.

2 Adjust set temperature to 36.0 ± 0.1 °C and Chamber Control to 0.

3 NOTE: At low ambient temperatures (below 22 °C) a low temperature alarm may occur, if this occurs, press mute and restart the test , the breathing circuit will eventually warm up and the humidifier will start controlling.

4 Check after 30 minutes:
Digital display is 36.0 ± 0.3 °C
Chamber outlet temperature is 36.0 ± 2.0 °C

If the unit is alarming or has not reached 36 ± 0.3 °C, press the mute button if necessary and leave for a further 15 minutes.

5 Then check the following in 'Engineering Mode' (see appendix A2):

set	36 ± 0.1 °C
offset	0
Edc	≥ 0
Cdc	≥ 0
hp	≥ 36 °C

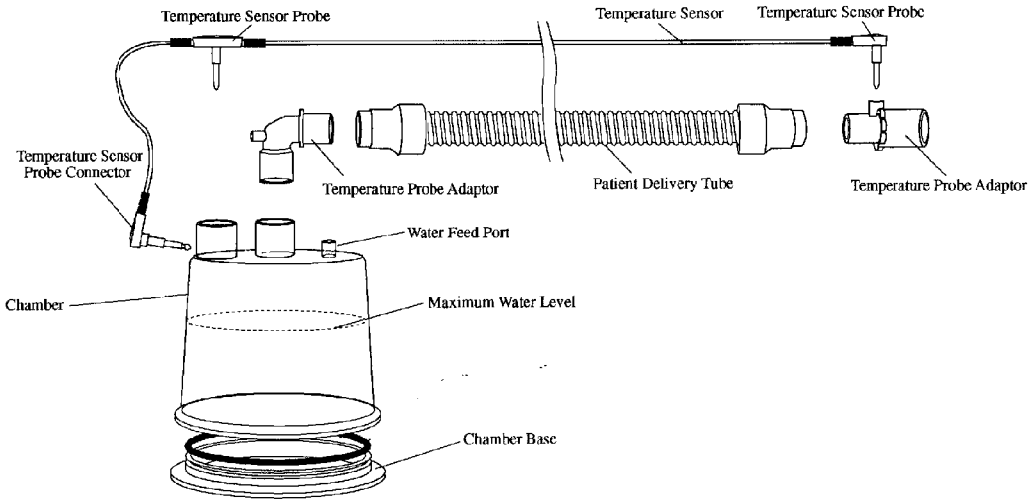
5 If unit passes this test it is controlling correctly and can be put back in use.

6

E.3 PERFORMANCE CHECK (MR480)

E.3.1 EQUIPMENT SETUP

Set up a non heated breathing circuit, see typical setup below:



Setup Notes:

- Patient delivery tubing can be single use or reusable.
- A gas supply of 2 – 10 l/minute to the chamber is recommended, if no gas supply is used, then the breathing circuit must be 22mm diameter to ensure adequate airflow.
- Use a dual airway temperature sensor, such as 900MR560.
- Use a Fisher and Paykel humidification chamber, such as a MR200 series, filled with cold water to maximum level (not a MR290).

E.3.2 SETUP

1 Fill the humidification chamber with water and slide on to the heaterbase.

2 If a gas supply is used, set to 2- 10 l/minute, if no gas supply used, the breathing tube should be supported from the patient end so that it drops vertically over its entire length to the top of the chamber.

3 Insert the middle sensor of the temperature probe into the connector on top of the chamber , and the end sensor of the temperature probe into the connector at the end of the breathing tube, plug the temperature probe plug in to the humidifier.

E.3.3 DYNAMIC TEST PROCEDURE (MR480)

1 Turn the humidifier on.

2 Turn Temperature Set control to 31.0 ± 0.1 °C, check that correct setting flashes on display after adjustment.

The airway circuit under the low flow conditions of the test will warm up only slowly and may give a low temperature alarm. If this is muted the circuit will eventually warm up and start controlling.

3 Check after one hour that digital display is 31.0 ± 1.0 °C.

If temperature is still outside these limits leave the test going for a further 15 minutes.

4 If displayed temperature is within 31.0 ± 1.0 °C, press chamber temp button and check chamber temperature is 35 to 66 °C.

5 In Engineering menu (appendix A2) check:
hp (heaterplate temperature) > 36 °C
Set = 31.0 ± 0.1°C

6 Check that disconnecting the temperature probe gives an audio alarm and Temp Probe LED flashes.

7 Press Mute button and check the alarm is silenced.

8 If the Humidifier passes these tests it is controlling correctly and can be returned to use.